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THE GEOGRAPHICAL JOURNAL

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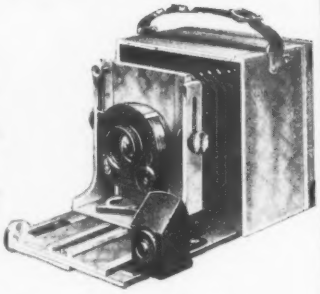

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All communications for the Editor should be addressed to the Royal Geographical Society, Kensington Gore, London, S.W.7. Authors are alone responsible for their respective statements. It is desirable that communications should be type-written. In MS. communications all new or unfamiliar geographical names should be written in imitation of Roman type.

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Feb. 13 The Island of Tahiti . . . . . Dr. Cyril Crossland
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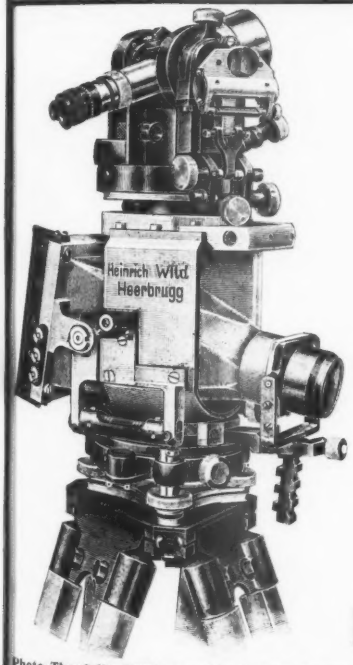

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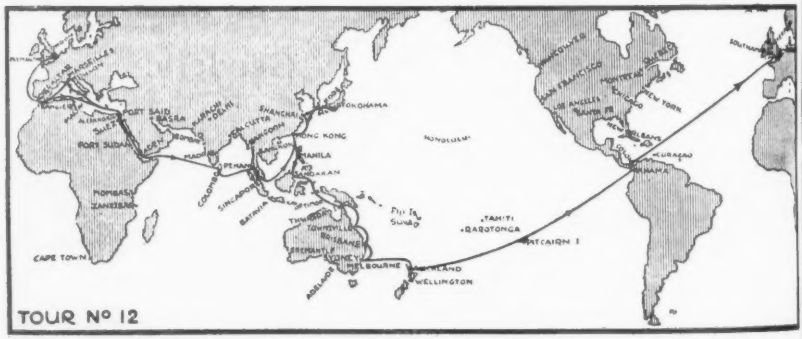

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The GEOGRAPHICAL JOURNAL

Vol LXXI No 2 R.G.S. *February 1928*

THE RIO BRANCO, URARICUERA, AND PARIMA:

Surveyed by the Expedition to the Brazilian Guayana from August 1924 *to June* 1925. *A paper read at the Meeting of the Society, 22 March* 1926, *by*

DR. A. HAMILTON RICE

THE area under consideration is Brazilian Guayana, and is the north-east portion of a huge quadrilateral that may be delimited by lines dropped from Bogota, Colombia, and Mount Roraima, British Guiana, to Iquitos, Peru, and Manaós, Amazonas, respectively, and the two western points connected with their eastern opposites by parallels. That region has been the object of my geographical investigations during the past quarter of a century, for the purpose of which seven expeditions have been organized and carried out. The route covered by the last has roughly the aspect of a "Z." Its latitudes extend from below 3° S. to 4° N., and longitudes from 60° W. to 63° 45′ W. The lower Rio Negro forms the lower limb, the Rio Branco the middle limb, and the Uraricuera–Parima the upper limb. The map following p. 208 covers the lower half of the whole: the upper portion will be published with the second part of the paper.

The objects of the expedition were:

1. To survey and map the Rio Branco with its western affluent the Uraricuera, following the latter to its source in the Serra Parima, and to ascertain whether any path or passage exists between the headwaters of this river and those of the Orinoco; thus tying this survey to the one carried out on the 1919–20 expedition. To try out the method of equal altitudes, *i.e.* New Navigation or Claude-Driencourt Method, by means of theodolites equipped with prisms, as a more expeditious and accurate way of working the astronomical determinations than the old time-honoured procedure with meridian altitudes and east and west stars. For this purpose, 5-inch and 6-inch micrometer theodolites (Casella and Troughton & Simms) fitted with Reeves' attachment, combining the theodolite and *astrolabe à prisme*, were used, thus obviating the necessity of taking along the last-named instrument, which is bulky and heavy, and whose use is restricted to the altitude 60°.

2. Further experiments, trials, and investigations of and with specially constructed wireless apparatus, designed for sending as well as receiving, particular attention being paid to portability, practicability, and efficiency of the field instruments.*

3. The utilization of a hydroplane † (Curtiss Sea-Gull type) to assist in and augment the survey work, especially as regards map sketching, traversing, and aerial photography in all its branches ; ‡ scouting, reconnaissance, and effecting communication between the working units of the party that might be temporarily separated.

4. Geology, particularly that part pertaining to the physiography of the region as a whole.

5. Anthropology, ethnology, and medical survey of the region visited.

The Uraricuera–Parima country is practically a *terra incognita*, in that very few have visited the region, and no one has ever attempted the ascent of the Parima portion of the Uraricuera. In 1787 the Portuguese Boundary Commission, under Governor Lobo de Almada, ascended the Uraricuera as far as the mouth of the Uraricapara, and more recently, 1882, the Venezuelan Brazilian Commission, under the direction of the naval Senior Lieutenant Francisco Xavier Lopez de Araujo, reached the same point and ascended the Uraricapara to near its source in the Serra Paracaima. The formidable rapids, savages, and eeriness of the country deeply impressed them, for a member of the Commission, one Dr. Dionisios Cerqueira, remarked upon the exploration of the region of the upper Uraricuera :

> "Those remote, mysterious and lonely regions, destitute of resources, and dominated by savage hordes of Maracanas and Kirishanas (Shirianas) and many others that infest them, the solitudes of the Parima will remain inaccessible to civilized man and wrapt in the mystery in which until to-day it has existed. Neither by the Uraricuera nor by the Mucajahy will it be possible to reach them, at present. The imprudent who ventures to penetrate such inhospitable solitudes with a regular expedition will either pay with his life for such rashness, or return without having reached his goal." §

* See "The Radio-Telegraphy of the Hamilton Rice Expedition, 1924–25," *G.J.* June 1926.

† "The Hydroplane of the Hamilton Rice Expedition, 1924–25," *G.J.* July 1926.

‡ "Photography of the Hamilton Rice Expedition, 1924–25," *G.J.* August 1926.

§ "Essas paragems remotas, mysteriosas e desertas, desprovidas de recursos e dominadas pelas hordas bravias dos Maracanas, Kirishanas e tantas outros que as infestam, as solidoes do Parima permanecerao inaccessiveis ao homem civilisado e envoltas no mysterio em que ate hoje tem excistido. Nem pelo Uraricoera nem pelo Mucajahy, poder-se-ha por ora la chegar. O imprudente que aventurar-se a penetrarse

Robert Schomburgk, a German, but working for English interests, made his remarkable journey in 1838–39. From Roraima he reached Typurema, which is the north apex of the north or Santa Rosa furo of the Uraricuera, 3 December 1838, and departed December 4 up the Uraricuera, reaching the mouth of the Aracasa December 26, from which point he continued his journey, December 29, working up the Aracasa. Afterwards crossing westward he descended the Rio Padamo, which enters the Orinoco a short distance above Esmeralda. He descended the Orinoco through the Casiquiare Canal to the Rio Negro, descending the latter river to where the Rio Branco debouches opposite Carvoeira. He ascended the Rio Branco and so back to British Guiana, whence he had started more than a year before.

Theodor Koch-Grünberg, 1911–12, travelled up the Rio Branco and entered the Uraricuera early in December 1911. The latter part of February 1912 he reached the mouth of the Aracasa, where he was detained a month. Afterward he passed up the Aracasa, following the route of Robert Schomburgk, seventy-three years previously. He turned to the west, also crossing by the Rio Merevari at a higher latitude than Schomburgk, eventually reaching the Orinoco by the Ventuari and working back from San Fernando de Atabapo to Manaós by the Orinoco, Casiquiare, and Rio Negro.

Dr. William Curtis Farabee, in July 1913, ascended the Rio Branco to Boa Vista and from there made several excursions. One was an attempt to pass up the south, or Maraca, furo of the Uraricuera. He ascended with a small party for three days, only advancing in that time to the first rapids, but gave up going farther on account of the great difficulties of navigation. He had heard that the furo Maraca was the south channel of the Uraricuera, which formed with the north or Santa Rosa furo a great island, called ilha Maraca. Farabee, however, says he did not believe any connection existed between the two furos higher up.*

Cyro Dantos, a Brazilian regatão (petty trader), with a Brazilian companion and several Macuxi indians, travelled in 1922 by canoe to Kujuma, which spot is opposite the mouth of the Rio Aracasa, on the right bank of the Uraricuera, and is the site of a Maiongong malloca and extensive clearings. Dantos ascended the Uraricuera by the north or Santa Rosa furo, and arrived at Kujuma in twenty-two days. He remained only one night at Kujuma, descending the Uraricuera by the same furo, the Santa Rosa.

Richard Spruce, in a letter written from Manaós in 1853 to his friend Matthew P. Slater, of London, speaking of the Amazons river, truly

com uma expedicao regular em tao inhospitas solidoes, ou pagara com a vida tanta temeridade ou voltara sem ser chegado ao seu destino."

* *Vide* "A Pioneer in Amazonia, the Narrative of a Journey from Manáos to Georgetown," the *Bulletin* of the Geographical Society of Philadelphia, vol. 15, April 1917. See page 61. Dr. Wm. C. Farabee died 26 June 1925, of pernicious anæmia.

says: "The largest river in the world runs through the largest forest." To this may be added that these are but two physical features of what is the largest peneplain in the world.

The low forested coastal plain includes that immense area named Hylea by Humboldt, and the relief features are represented by the Guayana and Brazilian highlands to the north and south respectively. The Guayana highland is a geanticline, the axis of which trends from 150° to 330° with eastern and western limbs that are erosion plains of uplift and warping. It is a region of folds and flexures, simple and complex, of blocks and masses, of metamorphism and distortions significant of strains and stresses to which the shearing, jointing, and fractures also bear impressive evidence, while the wildness and picturesqueness of the topography testify to denudation and erosion upon a great scale.

On the western limb from Esmeralda, working up the Orinoco, successive series of fault scarp ranges, Parima-Duida, Manaviche, and Guanaya, concentric or parallel to the main axis of the arch or Parima range, are evident.

Twenty miles west of Esmeralda is the Casiquiare canal,* a spillway of the Orinoco which runs off at a sharp angle from the main river, whose flow is west following the regional dip. A study of the map of the Casiquiare shows that the canal follows a *crémaillère* line, *i.e.* elbow turns significant of topographic control by one joint set to another in the shifting of the current. To the Casiquiare may be applied the conception of the strain rhomb, since the block under discussion is triangular bounded by a bedding plane and three or more sets of joints.† The bedding-planes have been planes of movement since they bound strata which have been bent, the pressure exerted against them being resolved into components parallel and perpendicular to the bedding planes. The parallel components on opposite sides of the stratum, the Orinoco side and the lower Casiquiare–Siapa side, produced one system of shearing planes corresponding to the distortion of a square into the strain rhomb, and the perpendicular component, causing two sets of maximum shearing planes oriented at 60° from its direction, produced a parting of the rocks along these two planes. A dragging effect was caused by the displacement of the adjacent stratum toward the anticlinal axis and an unequal development of systems ensued, the most obvious being represented by the line which the Casiquiare follows from the Orinoco to the mouth of the Pacimoni, the latter stream indicating the less developed system

Working up the Uraricuera, a consequent stream of the eastern limb, from its mouth at the old ruined fortress of São Joaquim, where the

* *G.J.* November 1921: "Rio Negro, Casiquiare Canal, and Upper Rio Orinoco."

† See Bailey Willis, 'Geologic Structures,' 1923, pp. 228–229. McGraw Hill Company, Inc.

1. *Manaos from the west, and the Rio Negro–Solimoes junction eight miles below*

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3. The lower Rio Negro, looking south-east from below the Rio Aputhe

Uraricuera * and Takatu join to form the Rio Branco, the impression conveyed is that of an undulating topography with not infrequent erosion remnants or monadnocks that in some cases rise considerably above the general level, but fail to indicate the true difficulties of canoe navigation in the hydrographical conditions prevailing. The Uraricuera throughout its length is an almost continuous series of rapids (caxoeiras) and strong currents (corredeiras) due to the river crossing transversely the parallel monoclinal ridges whose axis trend with that of the Parima. Approximately at right angles to these ridges are other foldings; the rectangular form of the joint blocks thus produced furnish evidence of topographical deformation by mechanical sheer.

For many miles the Uraricuera follows no well-defined channel, but spreads out over the erosion plain into a mass of waterways that hurtle over the bevelled edges of the eroded strata. To force a way through these labyrinthine courses is extremely difficult during low water, and impossible in times of flood. On a falling river the reefs simulating wing-dams cause ponding and spillways, but with much water coming down give rise to tailraces, forebays, cross-currents, and whirlpools, from and in the flumes and conduit-like passages through which the waters race. The river at many points runs between countless islands and aits, and is a seething, swirling mass of bubbles and spume, precarious to navigation and impassable to canoes working upstream. Overlying unconformably the erosion plain, extending from the eastern flank of the Serra Parima in the vicinity of the Aracasa and Parima rivers, in a north-easterly direction to Mount Roraima, are masses of sandstone stained a surface red by iron oxides, sandstones that at the mouth of the Parima are oolitic.† From this plateau of accumulation are hewn tabular mountains or mesas characteristic of erosion forms of horizontal strata. In ascending the Uraricuera the rock is first encountered at Uaimiti caxoeira.

In lat. 3° 15′ N., long. 62° W., the river swells out sac-fashion, and a whole archipelago is enclosed between its banks. From there for 40 miles to the east the river is bipartite. The two divisions (furos),‡ given

* Both words are of Tupi-Guarani origin, though, curiously enough, to-day no Indian of the upper Rio Branco nor of the Uraricuera throughout its entire length speaks a word of Tupi-Guarani (Lingoa Geral). Urari signifies the name of a poison which is widely used throughout tropical South America by the indigenes for poisoning their arrows. Takatu is in reality Itacatu, "ita" meaning rock, stone, and "catu" signifying beauty or goodness. The rocks and stones of the Rio Takatu are very nicely formed and in many cases of a red, jasper-like colour, hence the name of the river Ita-Catu. *Vide* Amarro Cavalcanti, 'The Brazilian Language and its Agglutination,' Rio de Janeiro, 1883; also Couto Magalhaes 'O Selvagem', Rio de Janeiro, 1876.

† This suggests a possible correlation with other sedimentary iron deposits farther south in Minas Geraes, believed to be pre-Cambrian, of the same age as the Lake Superior iron ores. The deposits in these two districts are not oolitic, but there are several deposits of oolitic iron beds in the Lower Palæozoic of North America.

‡ *Furo*, narrow channel connecting two sheets of water.

off from the north and south points respectively, are known as the north or Santa Rosa furo, and the south or Maraca furo, and enclose between them an island called Maraca. From reconnaissances with the hydroplane, made from Boa Vista early in November, reports were to the effect that the furo Santa Rosa was a more favourable roadway for canoe navigation than the furo Maraca. Both pilot and observer (Lieut. Walter Hinton, U.S.N., and Capt. Albert W. Stevens, Air Section, U.S.A.) were unanimous in affirming that, and both were dubious as to the possibility of canoes ascending the south furo at all, due to the multitude of physical obstacles that menaced navigation.

On the north furo, 8 miles below its commencement and 1½ miles above the confluence of the Rio Uraricapara, is the caxoeira Purumame, the largest fall in Brazilian Guayana, an impressively wild and beautiful cataract. The falls of Purumame exist by reason of a monoclinal flexure that trends across the country for a long way, parallel to the longitudinal axis of the Serra Parima. Purumame is an obsequent fault scarp 95 feet high with three steps formed by faulting. The strata on the upper dip side are schists: the strata exposed on the highest bench of the down side are highly altered plutonic igneous rock and an entirely recrystallized rock of sedimentary origin, a fine argillaceous sandstone. The second bench downward is quartz diorite, and the floor or base of the fall is highly metamorphosed granitic rock with a finely grained biotite schist. The recrystallized sedimentary rock probably belonged originally to the massive sandstone bed deposited upon the plain of erosion that to-day exists as the relict mountains of Marútani and Uaimití hewn out from a plateau of accumulation of Mesozoic sandstones. The Purumame remnant was so folded down as to be preserved from complete removal, and the inverted unconformity of its contact with the older beds brought about by such movements as transverse thrust. Later when the tangential compression was relieved, occurred the normal faulting with the resultant steps over which the river plunges to-day.

The Rio Parima is a subsequent stream flowing north whose longitudinal valley is formed within the easternmost peripheral range of the Serra Parima. The river, carefully traversed and plotted, follows a cremaillère line through deflection by the western limb of each anticline to whose respective pitching axis the river runs parallel, its eastern swings or deflections impinging at the respective synclines or downward pitchings of the axes. The series of long dangerous rapids forming the river are caused by the anticlinal western limbs whose strike is 150°–330°, at right angles to the local dip, 60°–240°; the spacings intervening between the hard ledges of the limbs and the monoclinal ridges divergent from the synclinal noses contain stretches of comparatively calm navigable water. As the river follows the local northerly dip, distinct from the regional easterly dip the rapids retreat very little upstream,

3. *Carvoeira, on right bank of Rio Negro above mouths of Rio Branco*

4. *Typical "white river" forest on lower Rio Branco, flooded at high wate*

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tending rather to wear away the hard ledges across whose strike they run, hence the absence of waterfalls. In its lower portion the river rushes through two deep gorges cut out of the overlying sandstone that rests unconformably upon granites which appear in the upper part of the higher gorge known to the Makús as Kulaihia. The granite is much sheared and the parallelopipedons of sandstone are significant of the same process of deformation and displacement. The sandstone terminates as a triangular hogback or "flatiron" on the eastern flank of the Serra Parima. It is again encountered on the west of the Serra Parima, apparently forming the serras known as Imeri and Tapira-pecu extending from the cabeceras of the Rio Padauiry over toward the Rio Negro alto, where granite replaces it. Farther to the west, from longitude 70° W. to the Andes, the sandstone reappears, tabular masses of it forming the wild and eerie scenery of the upper Caiary–Uaupes, Guaviare, Inirida, and Içana rivers. The Tapira-pecu and Imeri or Imei section is *en echelon* in respect to the east and west sections, its offset being south.

Just above Kulaihia gorge, the Rio Auari enters the Parima from the north-west; this is the stream used by the Maquiritares, Maiongongs, and Makus, when passing to or from the Orinoco and Uraricuera, there being a path from the head of the Auari to the Padamo, which last enters the Orinoco some miles above Esmeralda. It was by that route Robert Schomburgk crossed the Serra Parima to the Orinoco in 1838.

On 20 August 1924 the Expedition departed from Manaós, after several weeks of delay, due to the revolution then general over all Brazil. On the chartered river steamer *Parahyba* were put the supplies of the expedition, canoes, spare parts of the hydroplane; and the expedition's launch was lashed to the steamer's port side. It is 200 miles from Manaós to the mouths of the Rio Branco, and navigation in river steamers is possible 260 miles up the Rio Branco to the first rapids, the Caracarahy caxoeiras. The steamer acted as mother ship to the hydroplane, and was most useful in the mirror-black waters of the Rio Negro, where Hinton found coming down especially difficult, owing to the refractive qualities of the water, particularly so in the late afternoons. The wake made by the great stern wheel of the river craft was an excellent indicator by which to gauge correct distance for striking the water.

The Rio Negro was worked up along its north bank through the parana Anavilhana to Carvoeira, on the right bank, opposite the three mouths of the Rio Branco. The steamer was held a couple of days at Carvoeira, so that a traverse might be carried out of the Rio Amajahu, which is given off from a stream called the Xerihuny, just above. The latter enters the Rio Branco opposite União de Marara. Where the Amajahu empties into the Rio Negro in the big bay opposite Carvoeira, its mouth is accounted as one of those of the Rio Branco, the other

two being Marimari and the Rio Branco proper, named in order from west to east.

The Rio Branco * is a white-water river, as its name denotes, and for a considerable distance below its confluence with the Negro, the white water is discernible along the left or north side of that river. The mingling of the heavily sedimented white waters of the Rio Branco with the thin black waters of the Negro give rise to a dense vegetation, especially marked along the south bank, known as chavascal. White waters have special vegetation of their own, as do black-water rivers, and an anomalous growth, characteristic of neither, is to be generally observed when black-water and white-water rivers of any considerable volume come together. This is well marked at the confluence of the Negro with the Amazonas-Solimões just below Manaós, as well as at the confluence of the Branco with the Negro 200 miles above.

There are many islands in the Branco, and it is difficult at times to distinguish the channel. Above the Caracarahy caxoeiras the islands are less numerous and the river narrows, and from there to São Joaquim it is much easier to trace its course. For more than 100 miles north from the Negro the banks are wooded, a varzea † growth in general, not high as a rule, but single specimens grow from time to time of great height, with enormous spread and stout circumference of bole. Above Caracarahy, stretching northward to the foot of the Paracaima mountains in $4\frac{1}{2}^{\circ}$ N., are the campos, open plains affording grazing ground for cattle, and along the river on both sides are the great fazendas.

During the dry or winter season when the sandbanks are exposed, innumerable numbers of turtles and turtles' eggs are gathered, and there is good shooting. In time of flood the current ‡ is strong and the

* The Rio Branco does not show the horseshoe curves, swings, meanders, and concave dips opposed to shallow convex shores that are characteristic of most white-water rivers, as, for example, the Purus. There is not the amount of lateral erosion and tortuosity in the Branco that one would expect to find in a white-water river.

† The terms "terra firma" (Portuguese), "varzea," and "igapo" are used so generally that it is essential one should have a clear understanding of their meanings. The first is land high above the river-level, and never inundated; the second, land occasionally flooded at high water, but never to any depth; the third, land always in time of flood many feet under water. The vegetation of these three is naturally very different, as has been fully explained by various writers.

Vide "Mattas e Madeiras Amazonicus," pelo Dr. J. Huber, *Boletin do Museu Goeldi, Para*, vol. 6, 1909. Also Spruce, Wallace, Bates, Chandless, Smith, Keller-Leuzinger, Coudreau, La Cointe, and Ule.

‡ Major R. H. Blake (see *G. J.* May 1916) gives current in time of flood as 4 knots. During floods in August, September, and October 1924 the rate was taken over periods of 6, 8, and 10 hours, with Negus patent logs, which gave the current at from 2 to 2·5 miles an hour. With chip log and the formula rate per hour of the current = number of feet run out, divided by 100 times the number of minutes, 2·8 miles was obtained, though some of the men were confident at that time that a 4-mile current was running. The rate, such as it was, presented difficulties for the hydroplane in making landings.

banks in many places are inundated. At such periods neither fish, turtles, nor game are available.

From below the Caracarahy caxoeiras, lines of hills are visible from the river, and 20 miles below Boa Vista is Serra Grande on the left bank, a mass of granite whose base the Branco washes. Coming from the west are two fairly large affluents. The Rio Catrimany empties opposite a long island of the same name; it was ascended in former years to obtain the sarsaparilla which flourishes there. The second affluent, the Rio Mucajahy * (Kaiaunna), is said to rise a long way to the west, near the serra called Preguiça (Sloth), from which green stones of a jade-like hardness are obtained. This is of interest, as it is perhaps from there that the famous green Amazons stones of the eighteenth century were obtained.

On the Mucajahy reside the Pauxana Indians, a small nation the males of which are said to have and wear beards. My pilot, Dionysius Santos, of Manaós, an educated Portuguese, who has piloted on the Rio Branco for twenty years, made this statement, which was confirmed by reliable people at Boa Vista. I saw no Pauxanas during my stay at Boa Vista, however, so cannot corroborate it.

On the left side of the Rio Branco, opposite the mouth of the Mucajahy, is the Rio Quitauahu.† The principal tributary however is the Anaua, which is said to have considerable borracha (*Hevea Brasiliensis*). That river is used as a route to the upper Rio Jauapery, a river rich in balata (*Mimusops bidentata*) as well as borracha. The Jauapery is a tributary of the Rio Negro and enters the latter by several mouths about 30 miles below where the Rio Branco comes in on the north side. Between the Rio Negro and the Caracarahy caxoeira are two hamlets which mark former sites of towns of some size. They are Santa Maria and Nossa Santa do Carmo, on the left and right banks respectively. Navigation for river steamers ends at Caracarahy. The caxoeiras extend for about 4 miles, and around these on the right bank is a road termed the Boca da Estrada, employed for driving past the rapids the cattle that are brought down in big batelões from Boa Vista, landed just above the caxoeiras, driven into Caracarahy village, and embarked aboard the varengas (barges) for Manaós.

Vista Alegre is a trading post of the Araujo empresa, on the left bank of the Rio Branco, a few miles below the Caracarahy caxoeiras, at the end of a long broad stretch of the river (estirão). The expedition reached there September 4, and the place was made the first base. The cargo was unloaded, the plane disassembled, and a new engine installed.

* Schomburgk claims that a path existed in his time from the Wayamara settlement on the Uraricuera, which corresponds with the old Indian camping-ground of to-day, known as Kulekuleima, to the Mucajahy river, where there was a settlement of that name at the spot where the river was 40 yards wide. The Mucajahy enters the Branco a short distance to the south of Boa Vista.

† These two rivers mark the limit between the Amazonas forest and the open campos.

Swanson and McCaleb were sent forward to Boa Vista to erect a wireless station, with the idea to relay from that station to Manaós communications received from the field stations of the expedition, as it advanced from Boa Vista up the Uraricuera.* On September 7 both steamer and launch returned to Manaós, with those members of the expedition who were compelled to return to the United States by professional duties, my wife and Mrs. Richard P. Strong, wife of the medical director, who had accompanied the party to this point.

Unavoidable delay at Manaós precluded the possibility of return with the launch until October 12. On October 19, at Sororoca, a hamlet some 80 miles below Vista Alegre, information was received of the death, on October 9, of Theodor Koch-Grünberg, a member of the expedition. The launch reached Vista Alegre October 20, where it was found that Koch-Grünberg had died suddenly more than a week before, of malignant tertian malaria.†

On October 24 Hinton and Stevens took off in the hydroplane for Boa Vista, and on the 28th the main party followed in the launch, passing up the parana Nazareth, which is on the left bank of the Branco and leads into the Furo do Cujubim, a natural waterway around the Caracarahy series of caxoeiras, and although there are three caxoeiras in the upper reaches of the channel the passage expedites the ascent at certain stages of the water, as the very bad cross currents, whirlpools, and travessões of the main river are avoided for a distance of 4 miles to the so-called elbow, where the river runs over rocks and reefs that descending are easily enough negotiated by experienced pilots; but working up against them is a different story. Conceição, on the left bank of the Branco, was reached at 5 o'clock. The place belongs to my pilot, Terencio Lima,‡ where he has made an extensive clearing and raises tobacco, mandiocca, and sugar-cane. He has laid down a number of wood roads that extend some distance into the matta (forest). The matta here is comprised largely of ita-uba,§ a strong hard wood much esteemed for building houses and

* See "Radio-Telegraphy of Hamilton Rice Expedition." *G. J.* June 1926.

† Dr. Theodor Koch-Grünberg, a very eminent German ethnologist, geographer, and explorer, for thirty years was engaged in scientific investigations and researches, throughout the Brazilian and Venezuelan Guayanas and the Colombian Caqueta. He was the author of many valuable volumes on the indigenes of South America and their idioms. His series of photographs are notable, by reason of number, completeness, and beauty of execution. Equipped by training and experience, as well as by temperament and natural gifts, for his work, he will take rank among the foremost explorers of his time in South America.

‡ This man—small, wiry, and well advanced in life—spent eighteen months working on foot across the country from Manaós to Vista Alegre, an exploit worthy of chronicle among the archives of Amazonas achievement, for very few would attempt such a feat, and even fewer survive it.

§ It is the hickory of the tropics, a proper teak, and its specific gravity is heavier than water; it therefore does not float. It is used for the bottom and also sides of the hull in boat-building, while cedar is employed for the outboard work, and the thwarts

5. *Sororoca, on left bank of Rio Branco, 70 miles below Vista Alegre*

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batelões (large canoes). There were some dozen or more persons at Conceição in the ratio of three males to one female. The majority of the men were markedly icteric, thin, and showed unmistakable signs of malarial infection.

The river at Conceição is broad, and there is a long low island close to the right bank. To the south-west, 247°, are mountains, one standing out as a fang or tooth-shaped elevation. Terencio called it Tapirá-pecu. It is very similar to the peak to be seen from the Zamuro hills behind Esmeralda, called Pirá-pecu, which marks the frontier of Venezuela and Brazil. From Conceição up to Boa Vista, the river is broad and picturesque. The open country (campos) becomes more marked as Boa Vista is approached. The Serra Grande, a huge granite mass on the left side of the river, is a dominating feature all the way from Conceição to Boa Vista, a distance of some 50 miles.

Boa Vista is the only community on the river dignified by the name of "villa," and contains 164 houses with a population of 1200. A few of the buildings are of brick—the church, intendencia, several of the dwellings and armazens (storehouses)—but the majority are of the ordinary mud and wattle. The population is made up of Portuguese, Brazilians, half-castes,* Indians, and a few negroes of West Indian origin who have come in *viâ* British Guiana, but they are negligible.

Among the population are a number of soldiers classified as *Contingente Especial*. These are drawn from the regiments at Manaós and come to Boa Vista, where they settle for life, marrying and raising families. Their function is that of the colonial settler rather than a constabulary official, though they perform the duties of both. In a region, however, where judicial authority is irresponsible, semi-official constabulary is non-effective.

The influence of the Benedictine Fathers and Sisters residing at Boa Vista is apparent in the social and family life, for the standard of morality is high and evidences of refinement prevail among the white and Mameluco population, indicated by dress, manners, amenities, and accomplishments not commonly associated with wilderness communities. The scarcity of vegetables and fruits in a region that ought to be rich in agricultural products is accounted for by the fact that all labour is suborned for work on the fazendas. Those not engaged in such occupation follow the work of seringueiro (rubber gatherer) and balateiro

are made of louro. It is a Tupi-Guarani word, "ita" meaning stone, iron, or anything extremely hard; "uba" signifies tree, trunk, or casca.

* Brazilian half-castes include the following: Curibóca, cross between a white and indian. Mameluco, cross between curibóca and white. Cafuz or cabure, cross between indian and negro. Mulatto, cross between white and negro. Caboclo, sometimes used to denominate curiboco and mameluco, especially when they have a little beard, caboclo signifying such in Tupi-Guarani. Tapuio signifies direct descent from Indians, but also an individual who has benefited by whatever traces of civilization he has been able to assimilate. The term is sometimes applied in a derogatory sense to a caboclo, as a reproach to his semi-savage antecedents.

(balata collector). Husbandry is totally neglected—a matter of serious import to the country, as the population is deprived of foodstuffs essential to the physiological welfare of the community. The deleterious effects of the present ill-balanced, malnutritious dietary are very apparent in the generally adynamic condition of the majority of individuals presenting themselves for medical examination, advice, and treatment.

During the time the expedition remained at Boa Vista, from late October to early December, the party was ensconced in a large comfortable house, with the exception of the wireless operators and topographer, who were quartered in a building previously occupied by the members of the Commission da Defesa da Borracha. That dwelling was close to the wireless station erected by Swanson and McCaleb, which facilitated their work, much of which was at night, and disturbance of the other men was thus prevented. The six weeks of residence in the "villa" afforded excellent opportunity for studying the conditions of a colonial frontier river village of Brazil.

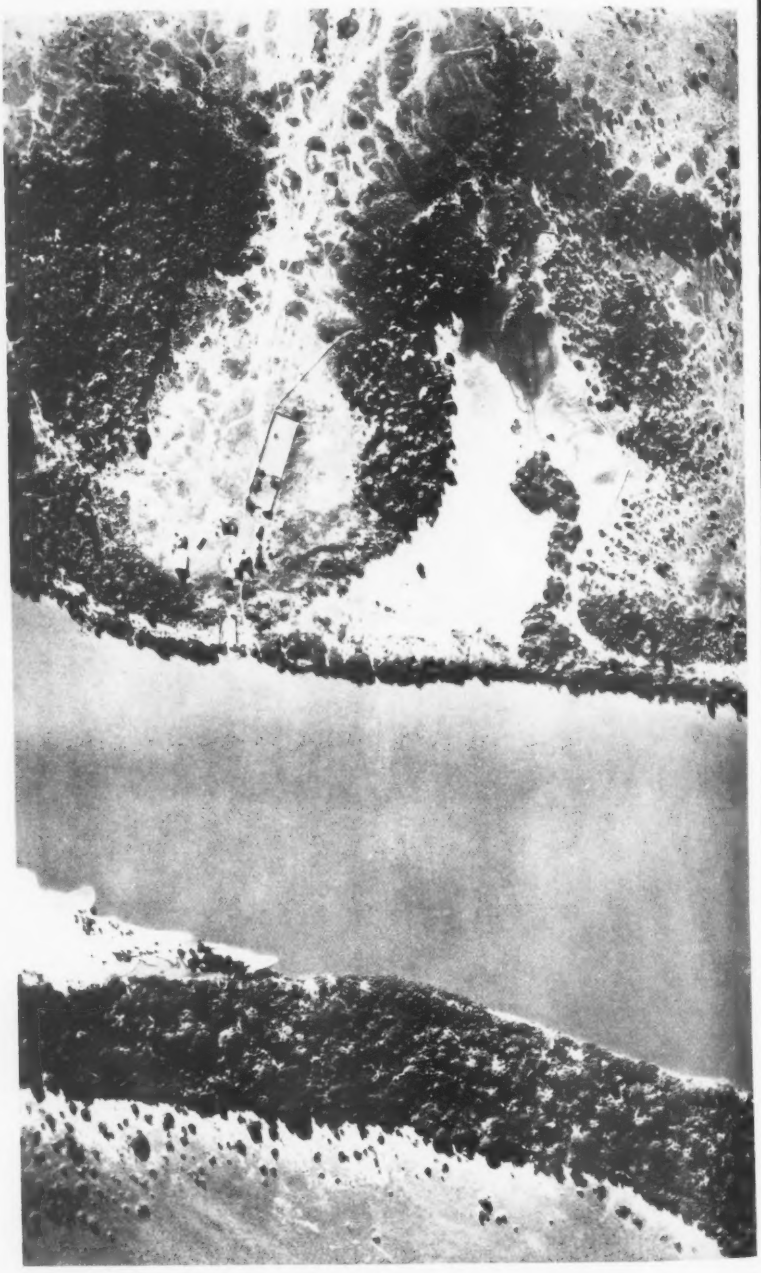
Medical work * was carried on most assiduously, and during the early part of November much reconnaissance work was done by the plane, and a good idea of the country for a distance of 150 miles to the west obtained.

During November Hinton went down with a renewed attack of an old infection of fever, and further work with the hydroplane was for the time being precluded. Couzens, the engineer of the launch, was also seriously ill for a period of three weeks, with obscure abdominal trouble, and certain other less important cases of illness among the men delayed the start upriver until December 3, when, with the launch of the expedition, *Eleanor II.*, and a small chartered one, departure was made from Boa Vista.

It is 20 miles to the junction where the Takatu and Uraricuera come together to form the Rio Branco. At the confluence of the two rivers are the ruins of an old Portuguese fort, São Joaquim. Opposite to São Joaquim is located on the right bank of the Rio Branco, the old parish of São Bento, marked to-day by an ancient chapel and a few houses. To the north-west of the old fort, on the left bank of the Uraricuera, is São Marcos, the site of the Fazenda Nacional, a Federal agricultural station maintained by the government for research, which to-day has a population of some sixty. All the savannah country round about, stretching to the north and west, is known as the Fazendas Nacionaes. Cattle were placed in the lower part about 200 years ago, and descendants of the original herds now exist along the Rio Parime to the latitude of 4° N. A sojourn of a few hours was made at the station and some cases of illness seen. These were due to faulty dietary, as was the case from

* *Vide* 'Medical Report of the Hamilton Rice Seventh Expedition to the Amazon in conjunction with the Department of Tropical Medicine of Harvard University, 1924-25.' Harvard University Press, Cambridge, Mass. 1926.

7. Boa Vista and the Campos from the south-east



8. Fringing wood and cultivated clearing on the Rio Takatu above Urariicuera junction

Boa Vista to Boa Esperança, most of the trouble being an entire lack of carbohydrates in the food of the people.

The Indians of this part of the country and extending north to Roraima are the Makuxi, Uapixana, and Jaricuna nations. Some may be included under the term *civilizados*, wearing clothes, segregated in small rural communities, and engaged in pastoral pursuits; while others go about with only a cotton cord around the waist, and a rag arranged under the crutch, T-bandage fashion. The women use a "moça," which consists of a trapezoid of beadwork some 10 inches by 8, hanging in front, with usually the Egyptian key pattern worked into them. These are very highly prized by the Indian women of the Maku and Mayongong nations who live a long way up the Uraricuera river, near the mouths of the Aracasa and Parima. Long voyages downriver to the eastern end of Maraca island are made annually by a few members of each tribe, to obtain these moças, bringing for barter canoes, paddles, mandiocca, graters and presses for the same, and hammocks.

The day's run was continued to an old fazenda house on the right bank of the Uraricuera, known as Cajual, some miles above São Marcos. There is open country on both sides of the river, which is flanked by long lagoons and shallow lakes, sanctuaries of thousands of birds and waterfowl, as garzas,* spoonbills, and marguares.

On December 4 we continued by launch 18 miles to the Fazenda Alagadiço, passing the Parana do Mauricio, which comes off the Rio Parime or Maua shortly after passing the mouth of that river. The house is placed a long way back from the river, and is set in a mangal† of thirty-two enormous mango trees. At Alagadiço there is an old house, now in ruins, nearer the river than the present domicile, between which and the main river, however, is interposed a big bog (alagadiço), running through which is a quebrada (brook) crossed by a stout bole. Rising from the bog is a great moriche (palm) dominating the horizon with its great fan-leafed top, and scattered all over the cleared land are heavy boulders of white quartz which resemble great blobs of mutton-fat jade. On this fazenda were cattle, horses, sheep, and goats, to the numbers of 4000, 1000, 100, and 80 respectively.

At Alagadiço the hammocks (capitiannas), as well as the chairs, were made of cattle hide, the first of long strips an inch wide and basket-weaved into a hammock. Everything was redolent of a cattle country, and reminded one of the Venezuelan llanos.

* The Brazilian refers to any place where many garzas are assembled as a garzal, just as he designates a very rocky place in a river, or where a mass of rock or collection of rocks are jumbled together, as a pedral—from Pedra (stone); and a morichale where exists a large number of palms known as moriche (*Mauritia flexuosa*) palms flourishing in the lowlands, frequently flooded—so that morichale has come to mean swamp or marshy place.

† Another example of the terminal "al" to express a collection or number of anything.

For most of the way up the Uraricuera, from São Marcos to Boa Esperança, the river is flanked on either side by campos, whose undulations are broken by single hills or discrete groups of granite elevations. The houses of fazendeiros situated at some miles from one another are generally surrounded by extensive bananeiraes, mangaes, roças (plantations) of mandiocas and macacheiras,* and orchards of goiaba and lime trees. Palmeiras of the inajá (*Maximiliana regia*) palm extend for great distances, and the aningas (*Montrichardia arborescens*) form a riparian selvedge. This last growth persists throughout the Uraricuera from near its mouth to where the Rio Parima enters at Tokixima-huaite, but disappears entirely on the Rio Parima. It is addicted to river-side places near granite caxoeiras, flourishing in the muds formed from sediments of white-water rivers. It is to be seen on the Casiquiare growing in profusion just above the mouth of the Rio Pacimoni before the Casiquiare entirely loses its character of white water. Along the lower Uraricuera in the open campo country flourishes the gorgeous yellow mata pasto (*Cassia reticulata*), which is first noticed in any quantity on the lower Rio Branco around Catrimany island, where the dense forest growth of varzea has been thinned out. Commonly associated with the mata pasto is the goiabeira (*Psidium guayava*), both ubiquitous through the campos. The predominating palms, in addition to the inajá already noted, are the mirity or muriche (*Mauritia vinifera*), murumuru (*Astrocaryum murumuru*), tucuma † (*Astrocaryum tucuma*), and assahy (*Euterpe edulis*). Oeiranas (*Alchornea castaneifolia*) grow abundantly along the lower Uraricuera and also throughout the Branco. On the latter stream are also considerable paruru (*Saccoglottis guyœnsis*) (*Humeriaceæ*), whose elongated leaves look not unlike those of the banana plant.

A few hours above Alagadiço we reached Gracios á Dios, belonging to the pilot, Dominguez Aibuquerque. Among the numerous family were several ailing members, their troubles due principally to a deficiency of the dietary. Dominguez wanted to remain, urging delay by reason of rough water and sunken reefs that rendered navigation precarious along that stretch of the river. With the sun in the east, however, and

* Manihot aypi (the yuca of the Spaniard), a variety of manioc, the root of which is free of the poisonous juice such as the *Manihot utilissima* contains. It is eaten baked, boiled, or fried, as a potato.

† Martius states the species of this as *Astrocaryum vulgare*, which is wrong, as pointed out by Dr. A. R. Wallace in his most comprehensive little work, 'Palms of the Amazon,' London, 1853. *Astrocaryum vulgare* is the botanical name of the tucum used as cordage for fish nets, bowstrings, and hammocks, while the tucuma, though closely allied, is never used for such purposes. The tucum differs from the tucuma by its broader bands or rings of black spines encircling the trunk, and the tucuma has globular fruit, more drooping leaflets, and its petioles have a characteristic swollen appearance. Brazilians never confound the two species. "*Astrocaryum vulgar* Martius," in brackets, after tucuma, on page 122, line 7, of Huber's 'Mattas e Madeiras,' is an error.

visibility good, no further delay than was necessary was allowed. A few miles above Gracios á Dios is the more elaborate and locally renowned chacara (country house) of Bento Brazil, one of the masters of the Rio Branco. His estates comprise most of the land on the left bank of the Branco and the Uraricuera from Boa Vista to the mouth of the river Majary, while the opposite side for the same extent is controlled by Senhor Araujo, universally known and called Jota Ge, from his initials J. G., a Portuguese citizen and most prominent resident of Manaós. These two are leaders of opposing factions, and in their hands and those of the Benedictine Abbot Eggerath, settled at Boa Vista, seem to rest the immediate destiny of the Rio Branco population.

The Rio Majary comes into the Uraricuera from the north, its mouth concealed by a long island that lies along the left or north bank. The small river Uamy empties into the Uraricuera on the right, opposite the upper end of the island, and midway between the island and the right shore extends a broad granite reef covered at high water, but a veritable pedral at low, though the caxoeira formed appears neither strong nor dangerous. Each time the launch ascended the caxoeira, rocks were struck, and in March 1925, when bringing up from Boa Vista members of the crews who were to man the canoes taking supplies forward to the expedition, one unfortunate fell overboard. He was seen to come up only once for a moment, then disappeared for good. A few days later two young Indians in a canoe, while searching for the body, were upset in the same place, and also perished. The people of the district affirm that an immense sucuriju (*Eunectes murumus*), anaconda or water-boa, known to inhabit that spot of the river, was the cause of their deaths. There are, however, other factors to consider—the heavily sedimented water, the strong cross-currents engendering suction, and the deep holes into which the bodies would be carried. All the way up the Uraricuera, whenever the canoes were capsized, the tendency was for them to be pulled under. A canoe, foundering in the Kulekuleima caxoeira, never came to the surface, but was found days afterward several miles downstream, half submerged.

A short distance above Uamy caxoeira, on the left bank, a German named Bamberg has a good house, extensive roças, and many cattle. He is married to a Manaoense lady, and there is a large family, after the approved manner of Brazilian colonial life. Bamberg's farinha is accounted the best on the river, and much prized by those who get it.

Between Apparecida and Boa Esperança are several caxoeiras. Passing upriver they are Preto, Missões, Tabai, and Pedra Grande. Preto and Missões were passed without difficulty, but the launch was carried back three times before Tabai caxoeira was successfully negotiated, the craft hanging at the crest on each try for five minutes. The right side of the river was first tried, then the left. After three unsuccessful attempts a heavily loaded punt being towed was dropped, together with

four men. On the fourth try the launch when well up toward the top was turned close to the shore to get advantage of the slack water and eddying, and reached the calm water above the travessão.

A canoe with the husband and two sons of an ill woman living a short distance above the caxoeira, urged medical assistance. It proved to be the same old story, the household a large one and the majority of its members ailing from a lack of proper nourishment.

Boa Esperança was reached early in the afternoon, not long after Arnold, Swanson, and the mulatto Antonio had arrived with the punt and Peterboro' canoe, the former fitted with an Elto outboard motor. They departed from Boa Vista five days in advance of the launch, in order to obtain astronomical observations at certain important points, and allowing for delays that might be occasioned due to cloudy weather.

Santa Rosa, the fazenda of Col. Besa, occupies the left bank of the river, and Boa Esperança, opposite on the right, is the port for Fausto Magalhães' house, which is half a mile back from the river, because in times of high water the lowland intervening between the campos and the river-bank is inundated. The port has a nice neat orange grove, a clearing, and is marked by a wide-spreading tree on the water's edge, whose hollowed bole afforded an excellent dark room to the photographers for developing.

The cargo sent up from Boa Vista to Boa Esperança through the month of November, by small launches and batelões, was stored in Magalhães' house, and several days were devoted to repacking. A hut for the wireless work was erected near the house, but that position proving not altogether satisfactory, a hill far enough away to check the ardour of the most curious was selected, and there a second hut and aerial were erected, and communication established with McCaleb at Boa Vista.*

From Boa Esperança two small launches of very shallow draught were dispatched up the north or Santa Rosa furo for a distance of 24 miles, reaching the foot of the caxoeira Typurema; and sacks of foodstuffs, gasoline, and other supplies were cached in a camp established there. Cyro Dantos, whom I had previously known when he lived at Barcellos on the Rio Negro, now regatão (petty trader) on the upper Branco Uraricuera country, and son-in-law of Colonel Besa, was taken on as capataz (overseer), whose mission it was to ride over the country and recruit Indians as crews for the canoes. His efforts in two weeks' time netted some thirty Indians—Makuxis, Uapixanas, Jaricunas, and Taulipangs. The tuixauas (chiefs) of the first three named headed their respective contingents. The Makuxis and Uapixanas had for tuixauas young men called Paullino and Alberto, respectively. Francisco, the tuixaua of the Jaricunas, was an old crabbed, cantankerous fellow,

* See "The Radio-Telegraphy of the Hamilton Rice Expedition, 1924-25," *G.J.* June 1926.

but a good workman, and easily enough managed by tact. There were also several mulattos and cabures, the latter always difficult to handle. Naturally deceitful and usually instigators of trouble, they are powerful physically, of great endurance, and capable of taking much punishment.

The Indian, put down anywhere by himself in the wilderness, can survive, furnish himself with whatever is necessary in order to maintain life, protect himself from wild animals and other enemies, undergo all sorts of privations, meet and better any of the contingencies that would be the undoing of the white man ; yet when it comes to a simple decision that a white man makes almost automatically, the Indian is dumb, motionless, and apathetic, lacking both the stimulus and the reflex. His adaptability to his environment is admirably attuned, but his initiative for progress and his acquisitive capacity early become rigid and unresponsive. If anything is to be made of the South American indigene, he must be taken at a youthful age, as the formative period is earlier than with the children of whites or of crosses.

Between December 6 and January 10, when the main party was moved from Boa Esperança up the north furo to the camp already established at the caxoeira Typurema, several journeys to the west had been performed by the hydroplane, and a point some 50 miles to the west of where the river divided into two furos had been selected as a favourable spot for an upriver camp for the plane to work from, as there was sufficient water then coming down and enough depth for the plane, as well as a stretch sufficiently long for taking off. To try to reach that point, Kulekuleima by name, with canoes and supplies, Bull and Shattuck with Indians were sent forward in two canoes December 16. On December 28, Camara, Santos, Domingues, the pilot with the smallest launch, a big batelão, eight Indians, and cargo were dispatched up the north furo to Typurema caxoeira, and to pass that if possible. The next day six more Indians were sent forward in one of the large canoes to help with the cargo sent up the day before.

In the morning of December 29 an ubá * appeared with Indians in it. These were so-called Shirianas, from the Rio Uraricapara, an affluent of the upper Santa Rosa furo, entering that part of the Uraricuera just below Purumame caxoeira. They were short, square-shouldered, flat-faced, round-headed individuals. Three of them were adults, the other a small boy, graceful and well formed. All were stolid, uncommunicative, shy, and not very curious. Their legs were not developed in proportion to the shoulders and arms, showing them to be river or canoe Indians. No one in the camp understood their language, with the exception of

* An ubá is a small canoe made of a single piece of wood, usually a tree-trunk which has been hollowed out, the bottom left very thick, while the sides are thin. They are excellent craft, especially in small and obstructed rivers where it is impossible to use the large canoes of batelão type.

Jesuino, a Makuxi living at Boa Esperança who had made the journey up the Uraricuera with Cyro Dantos, and who had remained up in the Mayongong country for six or seven months, taking to himself a wife, a Mayongong woman, whom however he did not bring downriver, as he already had a wife living at Boa Esperança. The fact of his matrimonial alliance with the Mayongong gave him certain standing with all the Indians of the Uraricuera. The Indians stayed until 3 o'clock in the afternoon, when they made off upriver again. It was afterwards found out the Indians had previously called upon Hinton and Stevens, who were in a camp a short distance above Typurema caxoeira, marooned on an island making repairs to the hydroplane, which met with an accident on the afternoon of December 24, just as they were starting off from Typurema to return to Boa Esperança. The Uraricapara Indians also called on their way upriver at the camp at Typurema, where at that time Santos and Camara with fourteen Indians were ensconced.

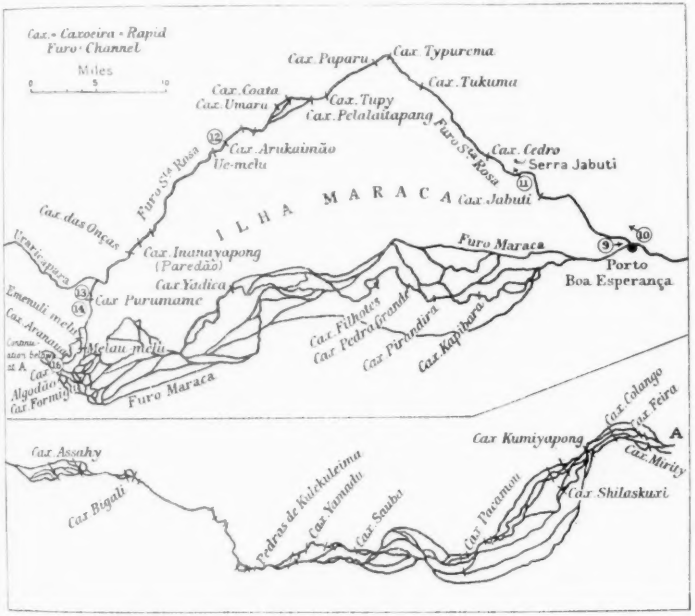
From time to time the plane was sent to find out how the first party which left Boa Esperança December 16 were faring. Their rate forward averaged from 3 to 4 miles a day, the river being extremely difficult to navigate by reason of the seemingly endless succession of caxoeiras, and the last report was that they were nearing what looked to be a large fall, around which portaging would be necessary. That was Purumame, an obstacle which stopped their progress 50 miles from Kulekuleima, and a camp was established at the junction of the Uraricapara with the Uraricuera. There Shattuck remained alone. Bull returned with the Indian crew and Dionisio Santos, the Portuguese Rio Branco pilot, who had become ill. Bull arrived at Boa Esperança January 5, having met Camara and Silvino Santos with canoes and batelões at a point about 7 miles above Typurema, they having left the last-named place January 3.

On January 6 Hinton and Couzens took off in the plane at 8 o'clock and headed due west upriver, then north-west to strike the north furo and report on progress of the canoes of Camara and Santos. Forty-eight minutes were consumed in reaching camp where Shattuck was, at the mouth of the Uraricapara. The landing-place in the river where camp was located was bad just below the Purumame falls. The hydroplane departed at 4 o'clock, and saw Camara's party of two big batelões going strong about 16 miles below Shattuck's camp, estimating it would take them two days more before arriving at the Uraricapara.

The main party departed from Boa Esperança January 10 by launch, with large and small canoes and one punt, reaching the Typurema camp the following day, an hour before noon. The camp was placed in a very picturesque situation, just over the caxoeira in the midst of high trees, and a deer shot just a short time before arrival was hanging up, being dressed. Wireless was erected, and Swanson got through to McCaleb at Boa Vista without the slightest difficulty. On the following day, the largest batelão, with six of the Indians under Jesuino, and a ton of cargo

was sent forward. January 13 the main body of the party got away in four canoes and a punt, a considerable portion of the cargo having to be left behind. After two hours' work, the island was reached where Hinton and Stevens lived from December 24 to January 2. Camp was made that night on a flat rock, past which the water rushed, on a spot not far above the mouth of the igarape Traihida. Opposite to the camp a small igarape enters the river, which for the most part is rock-lined, and offers but few places available for camps.

The first day from Typurema gave some indication of what was to



Sketch-map of the Ilha Maraca and section of river above the island (below) to illustrate the description and plates, pending publication of the second section of the folding map in the March Journal. Positions from which the air photographs were taken are numbered to correspond with plates and directions of the obliques are shown by arrows

follow, and each day thereafter was progressively worse. The river varies from amphora-like swellings to bottle-neck constrictions, and when actual rapids do not exist, there are difficult corredeiras (strong currents) that run like mill-races. Much of the time paddling and poling availed nothing. The only progression possible was made by long cables carried to far points, one group hauling and pulling in on the lines as another pushes and drags a heavy canoe over the slippery or sharp rocks that offer only precarious foothold, and which are dangerous

to limbs by reason of the holes, cracks, and furrows that corrugate or break the surface.

It was five hours' hard work to Pelalaitapáng caxoeira, where a portage was necessary through the granite hills that line the river at this point. The remainder of the day, from noon on, was spent in carrying the cargoes overland and passing the canoes. The two biggest canoes were passed over the rocks on rollers. At the worst part three men foolishly attempted to pass the punt, with the usual untoward results that follow when too few try such a proceeding. The craft was speedily swamped and wedged between great boulders in deep rapid water, that necessitated two hours' difficult work with axes and saws on the part of eight men. At the upper part of the caxoeira is much aninga, and at the end of two hours' hard work is a swift strong caxoeira, called by us Coatá.*

Only a short distance above that obstruction is the caxoeira Umaru or Karaiua. The big batelão that departed from Typurema the day before ourselves had just passed the lower falls, and its crew were having a difficult time in the fast water above. They signalled us to pass up the right bank, and five men from our party were sent forward to help them. More than four hours were consumed in getting the big batelão, the two canoes, and the punt past this obstruction; then two hours more of rocks and rapids, pushing and wading, when the top of the caxoeira Umaru or Karaiua was reached, around which on the left bank was a portage, a clean, well-cut path. Its condition was due to Camara's party, which passed on January 6, three days after having left Typurema.

Among the trees noted thus far along the north furo were, as regarded the palms, many assahy, inajá (*Maximiliana regia*), paxiuba-barrigudo (*Iriartea ventricosa*), and pupunha brava (*Cocos speciosa*). Other trees were tamacuaré (*Caraipa*), paracachy (*Pentaclethra filamentosa*), marupa (*Simaruba amara*), páo roxo (*Peltogyne densiflora*), páo mulatto (*Calycophyllum Spruceanum*), cumaru (*Dipteryx odorata*), and sumameira (*Ceiba pentandra*).

Several hours the following morning were spent in passing canoes past the caxoeira, as darkness precluded the possibility of finishing the work the evening before. After another day of rapids, reefs, and rocks, camp was made on an island some distance above two hills near the left bank. The island had a well-marked path across it, used by Indians as a portage in times of high water. Just above the island is a caxoeira not especially difficult to pass at this time, in falling water.

Next evening camp was made at 5 o'clock on the left bank, above caxoeira Arukaimão, where large trees were growing in the shallow soil. The big boles were supported by immense sapopenas (buttresses) that are invariably characteristic of forest growths in regions of rock formation that are covered with shallow soil caps. The earth resting on the rock

* The Urapú of Koch-Grünberg. Coatá (ateles), large monkeys; many seen here, hence the name.

9. *Looking east towards British Guiana from eastern end of Maraca island: Boa Esperança on south bank*

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pavement was laterite, reddish in colour. January 18, from 7 o'clock in the morning until 3 in the afternoon was a succession of rapids and water broken by innumerable rocks and aits, from Ue-melu to caxoeira Paredão or Inanayapong. The remainder of the day until sunset was expended in carrying the cargo overland, along the left bank. The rapids for three-eighths of a mile above the travessão make the work of dragging and pulling the canoes slow and laborious, and it was not possible to finish before dark. The following morning work was continued, and an hour after embarking a low caxoeira, C. das Onças or Sambura-melu, was reached and passed in half an hour's time. This was the last formidable obstruction before the mouth of the Rio Uraricapara was reached, at twenty minutes after noon on January 19.

Shattuck was alone in the camp, and reported Camara, Santos, and the Indians at another camp, just at the foot of the Purumame falls, a mile and a half above the mouth of the Uraricapara. A road had been broken through and constructed around the foot of the hill, on the left bank, and carried to a short distance above the upper falls. The Shirianas had come down the Uraricapara from their mallocas and returned upriver again, after signifying their intention of bringing food later. On the afternoon of our arrival they re-appeared, to the number of six, among them the three adults who had appeared some weeks before at Boa Esperança, but the boy was missing. In the afternoon the road which had been constructed from below the falls to above the uppermost travessão was inspected. It took twenty minutes to walk it from end to end, and a good camp and port were in readiness at the upstream side. There is an old trail which goes over the hill, running parallel to the river. This was utilized for portaging the gasoline cases, as the hard uphill work was easier than the canoe road, which was difficult for walking, by reason of its corduroy character and open bridges.

The height of Purumame fall is 95 feet, and the Uraricuera hurls itself over the travessões to the benches below, the whole hemmed in by a great gorge that accentuates the roar of the waters, making an impressive and inspiring spectacle, stupendous in mass and volume.*

The Indians complained of the coldness of the nights at the foot of the falls, and wanted blankets. They were also worried about pay, and were suspicious of Dantos,† who, unwisely, had threatened them with appropriating their pay should they not carry out his present desires, as well as retaliation for previous difficulties he had experienced with some of them. A spirit of mutiny was suppressed by assurance that they should receive in full everything which they had been promised. Before leaving Boa Esperança, Dantos had named a figure of wages for each Indian that I knew to be excessive. Nevertheless, I granted it, deter-

* The river Indians when visiting Purumame practise propitiatory rites. It is to them a sort of shrine or oracle.

† Dantos was disliked by the Indians principally on account of his father-in-law.

mined that each Indian should have payment in full for everything that each performed, based on the period that each remained with the expedition, and that Dantos's idea of appropriating whatever he chose from each Indian's pay would be defeated by the Indians receiving direct their pay in full, either in money or in goods, or both, as they might choose. It was now the time to explain this fully to them, and on assurance that Dantos was to have nothing whatever to do with their emoluments, they expressed a willingness to go on, with the understanding that they might return the end of February, or as soon as I succeeded in obtaining Indians of the upper river to continue the work.

Each Indian who returned to Boa Vista was furnished with his check, stating the number of days he had been with the expedition, and whether his payment was to be in money or goods. A duplicate check was sent by hydroplane for Couzens' information, who remained in Boa Vista in charge of the launch, to attend to the many imperative matters that required a capable person always at the expedition's base. With a counter-check to match that of the Indian who presented his, Couzens personally gave the Indian the money owed him, if he wished it, or accompanied him to the store, where the Indian was free to choose whatever sort of goods he might desire, and in addition was furnished with new clothes. It did not take long in Boa Vista for that sort of procedure to be known, and thereafter an easy matter recruiting men for the crews to be sent forward with the supplies, those going knowing full well the difficulties and hardships to be endured, but sure of receiving their pay.

One of the bad features in all the northern countries of South America is the lack of sense of responsibility as regards credit on the part of traders and others handling indigenes, and the pernicious custom of withholding from them a large per cent. of their pay on various specious pretexts. The relation of creditor to debtor is deplorable, accounting for much of the misery and backward conditions that prevail.

From Purumame it was necessary to send back several canoe crews to Typurema, in order to bring up the remainder of the supplies, for the transportation of which there had been an insufficient number of crews and canoes. Also one Indian suffering with a severe keratitis had to be returned to Boa Vista.

On January 22 the most reliable men were sent with their respective tuixauas, under the charge of Camara, to collect the cargo left at Typurema. They returned again January 29, a remarkably short time as it was; but the party would have succeeded in reaching Purumame the day before had it not been for upsetting one of the canoes at a bad caxoeira. On January 30 two of the largest canoes were passed over the road in one hour and twenty minutes.

On January 31 Cyro Dantos, with five of the Indians, started off in the large batelão for the caxoeira Typurema. The batelão was too heavy and too big for any of the work above, and had been severely damaged

11. *Santa Rosa channel and Serra Jabuti from the south: the Paracaima mountains beyond*

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13. *The Santa Rosa channel above Typarema falls; from about 1000 feet*

on the way up, requiring several days' labour on the part of Wilshusen to put it into any sort of condition again. It was also advisable to get the craft back before the river dropped any lower, and it seemed best to get Dantos away from the Indians. It was also necessary that several hundred pounds of carne secca, fifty baskets of farinha, and two dozen canoe paddles be brought upriver to Kulekuleima as soon as possible, these having been ordered by radio to Couzens in Boa Vista.

All of the time at Purumame, from January 19 to February 4, there was the general unrest that invariably ensues when any sizable body of Indians is held for any length of time at one place. One of the men hunting in the forest saw a big footprint. From that incident grew an ominous tale of fierce indios bravos that were suspected of lurking in the forest fastnesses and following the party to destroy it when opportunity should arrive. The Shirianas added fuel to the flame by declaring that higher up the progress of the party would be checked by large savage people who always killed any one who presumed to enter their territory. By reason of this the men, always suspicious, wanted to stay together, work together, and go forward as a unit.

The original plan had been to send two canoes back to Typurema, and to push forward with the others to Kulekuleima; but that was changed in favour of sending four canoes downriver with Camara, to return as soon as possible, with the cargo left there, and other supplies which Couzens was to dispatch by launch from Boa Vista to Boa Esperança. There was also much work to be done by those remaining at Purumame, transporting the cargo above the falls, and much repairing necessary on the canoes. Fortunately, the neighbourhood abounded with the sorba * tree (*Couma utilis*), whose white sap (leite) when boiled turns to a black pitch-like mass that makes an excellent tar with which to finish the caulking. Palms abound in this district, in addition to those already mentioned, pataua (*Œnocarpus bataua*), bacabá (*Œnocarpus distichus*), and paxiuba (*Iriartea exorrhiza*).† The imbaübas (*Cecropias*) are very high, as imbaübas go. There is much banana brava, Siroroca ((*Pacoba-Siroroca* (*Ravenala guyanensis*)), and many high trees in addition to the ubiquitous páo roxo (*Peltogyne densiflora*) and sumauma (*Ceiba pentandra*), whose names none of my men knew. The parapara (*Jacaranda copaia*) stood out conspicuously. The páo roxo usually accompanies black-water rivers, and the Uraricuera, while it is not a black-water river, becomes progressively darker towards its origin. The black, glossy veneer with which many of the rocks are coated in the Uraricuera is due to the action of iron oxides that play as important a part in colouring black-water rivers as does lime in the so-called white-water rivers.‡

* Called Pendari in Colombia. † Known as Macanilla in Venezuela.

‡ Black-water rivers, whose golden brown to mirror-black colour characterize them, derive their sable appearance from a stain or dye of iron compounds acted upon by humus acids. Where the action of the humus acids is inhibited by a large amount

On January 20 we were in wireless communication with Boa Vista. Our extra supplies of farinha, coffee, sugar, rice, oakum, paddles, and carne secca were ordered to be sent to the caxoeira Typurema camp. Hinton and Stevens, who were on the eve of leaving Boa Vista for Purumame, were informed that the water in the river was very low, many reefs showing, others just submerged, and that it would be extremely dangerous to land. The aviators replied they would remain in Boa Vista to await further advices.

We were in daily and constant communication with Boa Vista, sending and receiving advices on dispatch of the supplies, but at no time were conditions favourable for the hydroplane making a landing at Purumame. On January 25 Bull and Shattuck, with four Indians, were sent forward to Kulekuleima, in order to establish a cache at that spot for the hydroplane, as all signs were unfavourable for any chance in the immediate future of the plane being able to come to Purumame.

On February 4, at one o'clock, the main party started upriver. For an hour and a half there were strong currents (corredeiras) and caxoeirinhas (small rapids), after which portage was necessary on the left bank, path having been cleared by the three Indians going ahead in the curiara (a small canoe). There was much aninga growing all about in the sand and mud between the rocks. It took two hours to portage the cargo and pass the canoes; then for three-quarters of an hour were bad places, with one exception, where for a quarter of a mile there was smooth water. Next day the river was a series of caxoeirinhas running between islands, and there was a portage that lasted from a little after eight o'clock in the morning until 2.30 in the afternoon. Then came more pulling and pushing until a big caxoeira barred the way at 4.30, toward the head of which camp was made at five o'clock, there being a fairly clear path for portaging around this caxoeira, known as Emenuli-melú.

Through a forest of páo roxo and big rough-barked cedro branco (*Cedrela*), the close growth in all stages of the páo roxo is striking, as well as the great number of these trees to the exclusion of everything else, in contradistinction to the Amazonas forest that usually has but single members of different kinds of trees, and where in a hectare but few individuals of a type grow, there being great variety of kinds as well as diversity of size. The Guayana forest is of one kind, and lofty, totally different, also, from the caatinga forests of the Rio Negro. It resembles

of calcium carbonate, together with the decomposition of the feldspars of gneisses and schists, there ensues a condition of finely divided hydrous aluminous silicates which running water carries in suspension and which in turn impart to the water the turbid colour and erosive quality that characterize so-called white-water streams.

When the component substances that form a black-water and a white-water river neutralize each other there prevails a type of river whose water is thin, with little or no sediment, and colourless. The Rio Negro, the Rio Branco, and the Rio Takatu are examples of the three types.

somewhat the forest of the alto Orinoco, but the castanha (*Bertholecia excelsior*) and the cacáo (*Cacáo Silvestri*) are lacking.

On February 6, while passing the canoes through the caxoeira, Paullino with five men attempted to get his canoe up and over. The craft came broadside to the rush of water, and was wedged between upstanding and submerged rocks in a very bad position, and looked to be a total wreck. This happened at 9.30 a.m., and at 1 p.m. Raymundo cabure, Alberto the Uapixana tuixaua, and Paullino, decided to abandon it, and reported the position as hopeless. I refused to accede to such view, and in the afternoon men to the number of thirty were put on to the task of salvaging the craft. After more than four hours of pulling, hauling, and jacking, the canoe—or what was left of it—was pulled into view and lifted on to a flat rock on the left bank, which was cleared for a shipyard. A canoe ought always, in being passed up a caxoeira, to have a double crew, that is, if five men ordinarily compose its crew, then nine or ten should be used to man it at a caxoeira. Two canoes, at least, ought always be employed on a journey when fast water is likely to be encountered, and at the bad spots the crews of each combine to pass one canoe at a time. At Emenuli-melú, passage was delayed by the mishap from February 6 to 10, during which time the canoe was repaired, or practically rebuilt, by Wilshusen. A thorough search of the forest on either side of the river failed to reveal any sorba, and on the 9th four men were sent downriver to Purumame, returning early on the 10th with a gallon or more of the "leite." They reported the camp there as having been visited by the Shirianas, as there were many footprints and discarded tump carriers about.

On the morning following the wreck, Paullino announced that he had a "scisma" (evil premonition), and refused to go on. A quiet, well-mannered, willing Indian, one of the best of the lot as a swimmer and a worker in the canoes, I was extremely sorry to lose him. As tuixaua of the Macuxis, his influence over his men was excellent and his courage indubitable.

During the enforced stay at Emenuli-melú some of the men cut timber on the opposite bank to the camp, felling *páo da rainha* trees (*Muiracoatiara*) and cutting planks with the double-cross rip saws for the salvaged canoe. The land on which the páo da rainha flourished was a big island of hummocks and hollows, high trees growing on the former, the latter consisting of low varzea growths. A swift-flowing parana, broken with rapids, runs off at 70° from the main stream just above Emenuli-melú, entering below by our first camp, above Purumame.

There is game all along the Uraricuera: peccaries or Caetete (*Dicotyles torquatus*) and quexada or porco do matto (*Dicotyles labiatus*); deer (veado vermelho (*Coassus rufus*)), large monkeys (coatá (*æteles*)), tapirs (antas) and big tortoises (jaboti). Gallinaceous birds are the

mutuns, jacus,* cujubins, and inhambus, and the waders, the jacamins or agamis. Higher up on the river ducks, especially the big pato bravo (*Crairina moschata*), the Marreca cabocla, and the smaller marreca-ananuhy, were plentiful, and always a welcome addition to the larder. A number of snake birds (carara) were seen.

The river teems with fish from the big pacamou or jandia (*Pimelodus*) to the tiny sardinha, and among the finest fish may be cited the tucunare (*Cichla ocellaris*), surubim (*Platystonia fasciatum*) and bacú (*Doras*). Using the tarafa (net) at night with a flashlight, just below the mouth of the Uraricapara, three throws netted big numbers of fish, the majority of which were matrinchão (*Chalceus*), a perch in appearance; curimata (*Prochilodus reticulatus*), a curious-looking fish 16 inches in length, with loosely jointed, purse-string bag-like buccal appendage that accounts for its being taken only with the sweep net or arrow; and the pira-pucu, a long slender fish 22 or more inches, of pickerel formation, covered with white scales damascened by fine lines, a fish of great speed and quickness.

There are many pirahnas (*Serrasalmo* †), ferocious fish with terrible jaws. They destroy nets in which they are caught, and only the strongest hooks suspended from stout wire answer; others are useless. Bathing, by reason of the pirahnas, is dangerous except in the rapids in shallow water. There are also electric eels (puraques) and sting rays (arraias), both unpleasant bathing companions.

The principal pests in the camps were tucandeiras, giant ants whose bite is excessively painful, small biting flies (mariums and pium), mosquitoes (carapanas), ticks (carapatos of the species *amblyomma* and *dermacentor*, suspected of transmitting Leishmania americana), mucuims or red bugs, and chiggers.

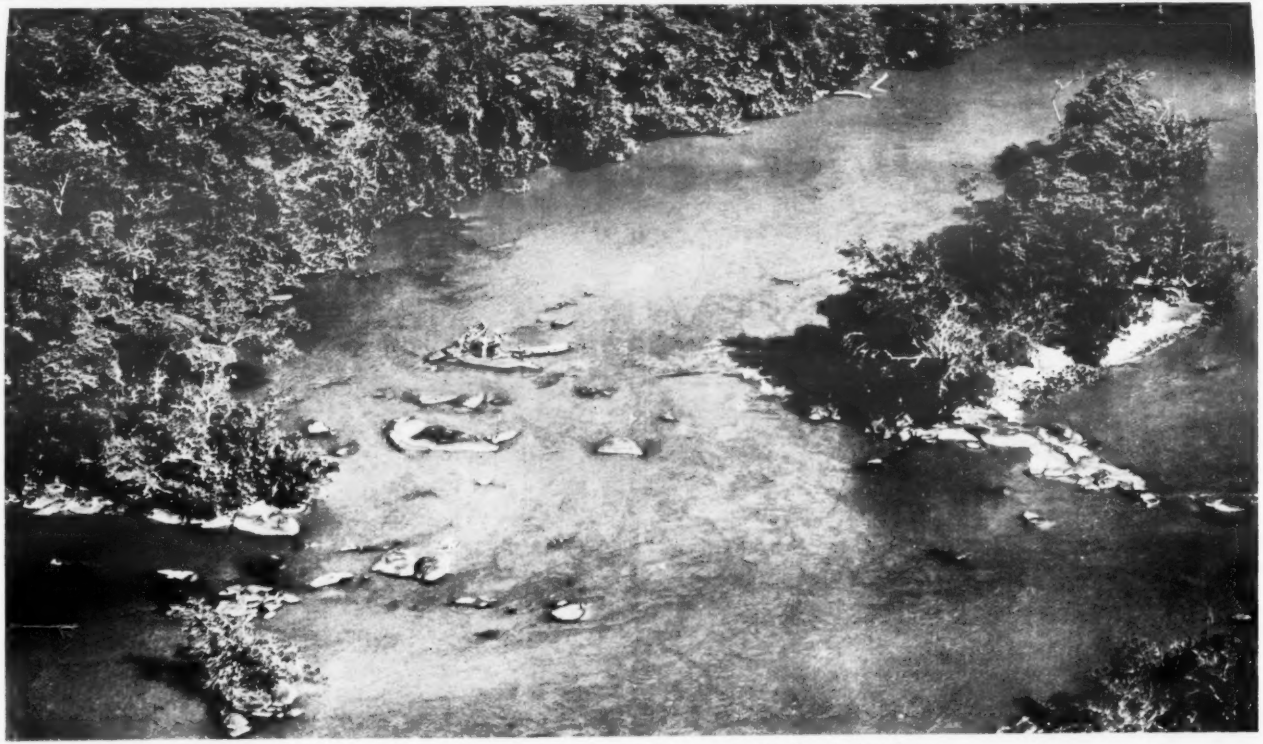
Large spiders (caragueijeras) were encountered occasionally, one the diameter of whose circle measured 10½ inches. Five sucuriju, anacondas or water-boas, were killed on the voyage between caxoeira Typurema and Kulekuleima, and of the venomous serpents the jararaca-assu (*Lachesis lanceolatus*) was most met with, usually in the camps.

From time to time in ascending the river, great hawks (gavião real) were to be seen, perched on the topmost limbs of lofty trees, which afforded a fine eyrie. These birds in appearance are not unlike eagles. Macaws, maracanas, parrots, pigeons, toucans, and gaivotas (small gulls) are plentiful.

The cargoes having been transferred to the caxoeira above Emenulimelú, we left at 2.15 p.m. on February 10, and in little more than half an hour the caxoeira Melau-melú was reached, where the travessão is 15 feet or more in height. The river between the two caxoeiras is turbulent and filled with islets and rocks. It was necessary at Melau-

* Jacus are the pheasants of the country, cujubins the turkeys, and inhambus the partridges.

† The caribe of Colombia and Venezuela.



12a. *Canoe party on rock waiting supplies by hydroplane*

13. *The upper and middle Pyramine falls*

melú to portage cargoes and lift canoes over the travessão, work not finished until sundown. The day following there was no obstacle for three quarters of an hour, then fifty-five minutes to pass a caxoeira that extended through side of an island, necessitating portaging. Half an hour above that point Bull was met, returning to Purumame for cargo from Kulekuleima, where he had left Shattuck and one Indian on the afternoon of February 9. An hour above the first caxoeira was a second, which took the best part of an hour to pass, and it was not until 1.30 p.m. that the canoes were under way. The caxoeirinha necessitated twenty minutes' more delay, and above this the river becomes choked with rocks—a veritable pedral. At 3.20 p.m. a caxoeira required an hour and twenty minutes to carry over and portage the cargoes. Twenty minutes later a short steep one required twenty minutes, then a way was forced through a narrows that gave outlet into the main body of the river, again with a caxoeira a few hundred yards upstream. Camp was made on the right bank, and in a few moments much excitement caused by a "Jauapery" * seen crossing the top of the caxoeira from the right to the left bank. For hours the men excitedly discussed Dantos' tales of the indios bravos reputed to inhabit the western end of Maraca island.

Next morning, February 12, Jauapery caxoeira was passed, so called because of the Indian seen the night before. It was a good hour and a half before the work was accomplished, and nine o'clock before the canoes were under way. A caxoeirinha a short way up was easily passed, and an hour later a formidable caxoeira, Aranaua, was reached. Here a channel had to be constructed along the left bank by lifting rocks and cutting away the dense overhanging vegetation. The portaging, dredging, and canoe hauling consumed an hour. At the Aranaua rapids the river hurls itself in menacing fashion, with dizzy swiftness and great waves, down the incline, running due south, while at Emenuli-melú it races and tumbles along due north, the river having the form of a deep "U."

For a very short way above Aranaua there is smooth water, then a caxoeira on the down side of which we camped for breakfast, passing the canoes at the same time. Above the caxoeira for half an hour it was possible to use the outboard motors, but lines for pulling and hauling had to be resorted to at a strong correntada which took half an hour to pass. In a few moments more we were on the north side of Kumi-sade, a big expanse of water filled with islands and rocks, an inland archipelago of labyrinthine plan and pelagic proportion, across which a strong current sets easterly and southerly. This is the western end of Maraca island, where the river divides into the two furos.

Skirting the north bank, an old camp of Bull and Shattuck was passed, and a short distance above, a corredeira (strong current) caused

* The wild Krishanas of the upper Rio Jauapery are confounded with the Shirianas of the Uraricuera by reason of similarity of name, and all Indians west of the east end of Maraca island are commonly referred to as Jauaperys by the Rio Branco people.

13. *The upper and middle Parimanaw falls*

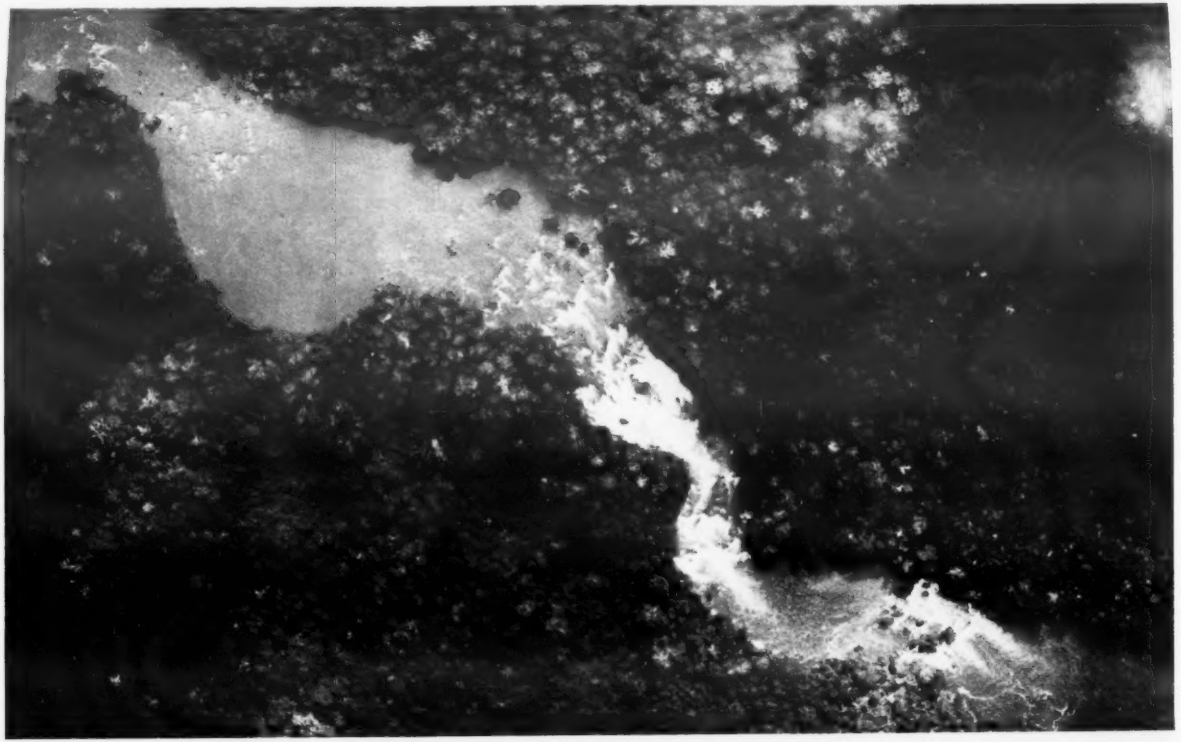
fifteen minutes' hard work. The curiara (small canoe) just ahead with Andrade and José, who were acting as hunters and fishermen, shot a tapir (*anta*) on the north side of an island at the western end of which emerged a parana into which the canoes were pointed. On the south-west end of this island a good camp site was found. In addition to the tapir killed, a big pacamou and several tucunare were caught. The tapir cut up, as well as the pacamou, was "moquearuára," * smoked, thus ensuring meat for some days. Much aninga was growing on the island front, and the ground was covered with white petals of some convolvulus, the leaves of whose trees were long, narrow, and quintuple at the end of each stalk.

The night was an especially dark one, with distant thunder and vivid flashes of lightning varied with the occasional howls of an onça. In the morning, with coffee and biscuits, Candido, camp mess boy, brought beautiful hyacinth-like sprays of white and very fragrant flowers. A series of narrow channels, rock lined on both banks through which the water raced, was ascended. They appeared to form the main middle channel, flanked with strings of islands between which, sometimes as though they were breached, water flowed from the north into the channel we were following. Numbers of otters in pairs (madaque) were swimming about and barked defiantly at us. At eleven o'clock we stopped at a small piece of praia to wait for the other canoes, old Francisco's clumsy batelão not arriving until an hour and a half later. A hard but short downpour occurred just after midday, and the canoe fleet was under way at 2.15 p.m.

The course all day was nearly due west, and during the afternoon water fell into the trough that we ascended, from the north and south sides. At 4 o'clock we came up with Andrade and José in the curiara, whose progress had been stopped by a caxoeira, at which point the river was divided into two channels, the larger and more formidable to the north, the smaller and not very promising one on the south. Camp was made on the right bank, the only possible place, the canoes crossing over from the left or north bank up which they had worked at some risk, as a powerful current was running with bursting whirlpools and dangerous vortexes. The caxoeira was called Mirity, from the number of very fine mirity (*Mauritia vinifera*) palms on the right shore. Reconnaissance work was carried on until sundown, but availed little.

Next morning at 8 o'clock the curiara led the way up the caxoeira, which was a series of steps on the right of which it was possible to haul and push the canoes up to near the crest—laborious work. At the top,

* Done with a rack made by driving three or four poles into the ground, forming a triangle or rectangle. The uprights are notched and hold the frame upon which sticks are laid crosswise to make a platform about 2 feet above a slow-burning fire which smokes the meat or fish. To be well done takes several days. Moquear is the verb; the past participle is formed by the suffix oára or uára.



14. *The Purumame falls from the south*

16. The Uaricuera below its bifurcation into Santa Rosa and Maraca channels; Aramana falls upper

the canoes, emptied of everything, bow and stern lines adjusted, were pulled through singly, by triple crews. Once over, the advance was slow up through the narrowing sombre passage, until Raymundo caburé returned from ahead to say it was not possible to pass the canoes on account of the high caxoeira existing at the head of the parana. Investigation disclosed a rock-lined conduit-like passage, down which the waters swirled, the brawling turbulence further enhanced by three plunges the river makes during its descent. The island on the right is cut up by a network of furrows trenched in the rock, due apparently to the violence and volume of water coming down in floods, added to the difficulties of progress, and is one of the many striking examples of the very shallow cap soil overlying the rock basement of the region.

At the top of the flume a fall of considerable height exists, over which the river throws itself tumultuously. At 2.30 p.m. we were back at the point where we had commenced ascent in the morning, and now the south parana was attempted, following up the south side of the island, along whose north bank five hours of futile effort had been expended. The bow of the first canoe to be pulled around a bad point was, for some unaccountable reason, released, and the stern line held so that the craft was swept broadside to the rush of water and swamped. All floating things, as clothes bags, food boxes and gasoline cases, were carried rapidly toward the whirlpools below, and would have been lost had not the Indians with admirable quickness of mind and action swum for them and retrieved the cargo. Afterwards they dived for the heavy articles that had sunk in some 8 feet of water. In this way much was saved that otherwise would have been lost. The other canoes were unloaded and the cargoes transported overland. Above that bad spot others intervened every few yards, and darkness came on, putting an end to a hard day that a heavy rainstorm finished up in gloom, with one half of the party upstream, separated from the other by a quarter of a mile or more. Early next morning the lower party and canoes were worked up to the upper camp. Then three men in the curiara were sent forward with orders to make a thorough reconnaissance to see if any way existed by which the caxoeira of the flume could be surmounted. They returned late in the afternoon, reporting that they had found a very small canal, through which the canoes could be passed, that came out a short distance above the falls. On the next day, February 16, the entire party started up-river, following the curiara. Most of the day was spent working up an umbrageous passage, at times no wider nor deeper than a brook, at many places of which the canoes had to be pulled over the rocky surface. The trees formed so thick an arch as to obscure completely the sunlight, and at a little after midday the roar of falls was plainly to be heard a short way to the north. Occasionally a stream more of a parana character was entered, the most prominent vegetation of which were magnificent specimens of the Pataua palm. Then again the canoes would be en-

veloped in the labyrinthian masses of islands, whose small trees interlocked close to the surface of the water, making it extremely difficult to work with the poles against the rapid current, the rock bottom affording as much difficulty to the poling as the dense arch of vegetation overhead. Paddling was of little or no avail, the conditions prevailing rendering any method of ordinary progression ineffective. No suitable place for camp was found until 5.30 p.m.

The next day the work was under more open conditions, but many islands, caxoeiras, and pedrals contributed to difficult conditions. In the afternoon, after working up a bad caxoeira Kumiyapong by means of a small channel up which it was just possible to pass the canoes, and with difficulty forcing a passage through the labyrinth of small tortuous paranas that formed an intricate network on the north-west side of the caxoeira, similar to those of the day before, we emerged a little after 5 o'clock into the broad river again. A good camp site was found on the left bank a couple of miles up, which the last canoe reached at 7 o'clock. At 6 o'clock three shots of a heavy rifle were heard to the south. These were answered, but no reply came. The canoes coming in late reported having heard both sets of shots, though ignorant of their origin.

February 18 was a day of caxoeirinhas, corredeiras, and pedraes. Much time was lost in the afternoon, owing to difficulties with the water system of the Caille engine in the punt, which was the radio boat, the engine being used not only for motive power, but to charge generators as well. Camp was made at the foot of a caxoeira, called Pacamou, by reason of a large pacamou caught there. The next day the swift-running paranas, corredeiras, and pedraes continued. In the afternoon, three hills were passed, with favourable water for running tows, the canoes provided with outboard engines towing or pushing the others. At 4 o'clock a caxoeira with three islands across it necessitated three quarters of an hour's labour to pass, and again at 5 o'clock another caxoeira stronger and more difficult required an hour and a half. Just above it on the right bank a favourable camp site was located.

The next day two caxoeirinhas and a pedral were obstructions that offered no great difficulties, and in a little under five hours the Pedras de Kulekuleima was reached, where Shattuck, Hinton, and Stevens were found at a spot on the left bank of the river possessing ideal conditions for a camp. The hydroplane with Hinton and Stevens had departed from Boa Vista for Boa Esperança on the 16th, and taken off from the latter place on the 17th, just missing the ledges and reefs by inches. It was on that day, at a little after half-past eight in the morning, that several of the canoes had seen the plane, and on the evening of that day that the rifle-shots had been heard in the paranas to the south of our camp. An hour and a half after our arrival at Kulekuleima, Dantos arrived in a heavily loaded canoe, and vouchsafed the information that it was his shots that we had heard on the 17th, he having departed from Typurema

February 7, and from Purumame on the 12th. On February 15 and 16 he lost two entire days, having encountered many caxoeiras. On the following day, in the middle of the afternoon, he heard one of the motors, and met two ubás, each filled with Maiongong Indians, on their way down-river. On February 18 conditions were easier, and different paranas were sought to meet the expedition, without avail. On several occasions the motors had been distinctly heard, and twice at the end of a long reach the canoes had been discerned, but immediately lost to view. Late in the afternoon of February 19 he came to where the river becomes a single stream, and resolved to await the expedition, though he was uncertain whether it was ahead or behind him. Early in the following morning he heard shots that were below him, as he thought, but the expedition reached Kulekuleima over an hour ahead of him.

The difficulties of navigating such a river may be understood when it is reflected that the river in many parts widens out and flows along, not in one, two, or three paranas, but many that are separated from each other by labyrinths and waterways divided by islands, many times roofed over by a dense vegetation, a condition known as fechado, through which any form of progression is extremely difficult.

Kulekuleima * itself is a very picturesque spot on the left bank of the river, where two great reefs, or lages, cross the river, trending 60° to 240°, and forming a broad travessão that emerges near the right bank to form a rocky islet covered with thousands of orchids (*Cattlyea violiaceæ*), while the right bank is densely wooded to the water's edge, and just below the islet an igarape comes in. Kulekuleima is forested with high trees, and below the travessão is a fine beach, while above is a bay, formed by the ponding back of the water by the travessão, which answered admirably as a harbour for the hydroplane. Some of the great tecoma trees were in flower, as happens in February, and their rounded tops, a mass of chrome yellow, added a magnificent touch of colour to the whole.

(*To be continued.*)

* Kulekuleima is historic as the scene of a fierce battle three or four decades ago between the Shirianas and the Maracanas, in which the Maracanas were almost exterminated. The great rock is said to have dripped with blood. The remnant of Maracana survivors retreated south to the fastnesses of the upper Rio Mucujahy, where they exist to-day, and are reputed to return sometimes to the cataract region of the Uraricuera below Kulekuleima to make nocturnal attacks upon the travelling Maiongongs and Makus.

GRAVITY SURVEY BY SUBMARINE *VIA* PANAMA TO JAVA: *A paper read at the Afternoon Meeting of the Society on* 12 *December* 1927 *by*

DR. VENING MEINESZ

IN 1926 I had the pleasure of reading to you a paper on a new pendulum method for determining gravity at sea, and about a voyage in a submarine from Holland to Java, during which this method had been put to the test; I am glad now to be able to give you a communication about new investigations in this direction.

The satisfactory results which the method had given warranted the construction of a new apparatus, especially adapted to render the observations more easy. This was done in 1925; in the autumn of that year I made a shorter submarine voyage to Port Said, to submit the apparatus to a trial. It entirely fulfilled my expectations; and only a few alterations have been made subsequently, of which the most important is the suspension of the apparatus in gimbals, which involved the combination of the pendulum apparatus with the photographic recording apparatus in one whole. In May 1926 I started on a voyage with the submarine H.M.S. *K XIII.* from Holland *via* Panama to Java, where we arrived in December.

I propose now to give first a short general survey of the principal features of the new apparatus, and then a record of the last voyage and its provisional results.

Before speaking about the apparatus, I will recall to your attention the principle of the new method. This consists in the possibility of eliminating the effect of the horizontal accelerations of the ship, which cause by far the greatest disturbance in the pendulum movement by swinging two pendulums in the same plane with some difference in phase or amplitude. In the equations of motion of the two pendulums there enters a disturbance term, which is a function of the same unknown horizontal acceleration, and so this acceleration may be eliminated. When the two pendulums are isochronous, this elimination is effected simply by taking the difference of the two angles of elongation; this angle may be considered as the angle of elongation of a hypothetical pendulum, which is free from the disturbance.

In this way the principal disturbance caused by the movement of the ship is nullified. Of the other disturbance terms only two are not negligible, provided that the ship movements are small, which may be attained by making the observations in a submerged submarine. There is first the disturbance caused by the vertical accelerations, which practically disappears on taking the mean for an observation of not too short duration, *e.g.* half an hour; and secondly the disturbance caused by the deviation of the plane of oscillation from the vertical, so that not gravity itself is measured but its component in that plane; this dis-

turbance is small because of the cardan suspension of the apparatus, and it is easily possible to take it into account if the deviation of the plan of oscillation is recorded throughout the whole observation.

The new apparatus contains three practically isochronous pendulums, Nos. 1, 2, and 3, swinging in the same plane. They are combined in two pairs for the aforesaid elimination: Nos. 1 and 2, and Nos. 2 and 3 which control each other. The principle of the apparatus is not to record each pendulum separately, but to get at once the difference of their angles of elongation: $\theta_1 - \theta_2$ and $\theta_2 - \theta_3$. These two records have the same appearance as the record of a single pendulum, undisturbed by the chief cause of disturbance, the horizontal accelerations. In fact they are nearly regular, as may be inferred from the illustrations; the vertical acceleration gives only a slight fluctuation in the white marks which represent the chronometer beats, but the amplitudes remain rigorously unaffected by this acceleration, as may be shown theoretically to be necessary.

The chronometer marks referred to are caused in the following way: the two chronometers have each an electrical contact and may act in this way on two little shutters, which for a short moment shut off the light. One of them is a sidereal chronometer and one a mean-time one, and this gives a difference in the curve of the marks. The mean-time chronometer is in period nearest to that of the pendulums, and therefore the curve slopes less than that of the other chronometer. The chronometer marks afford of course the means to determine the times of oscillation.

Besides the two principal records the apparatus gives a curve representing the position of the plane of oscillation, obtained by recording the angle of deviation of an auxiliary pendulum, which is strongly damped to prevent oscillation; and another curve giving the temperature of the air in the apparatus, and in this way checking the indications given by the thermometer enclosed in the dummy pendulum. The temperature question is rather important because brass pendulums were used, as it was feared that invar pendulums would be too much subject to uncontrollable magnetic disturbances in a submarine; an exact knowledge of the temperature is therefore desirable. The new apparatus has accordingly been provided with a good temperature insulation. Further, it has a device for making it possible to keep the pendulums enclosed during the whole voyage, in order to improve the regularity of their temperatures. For this purpose they may be lifted from their knife-edges and fixed with springs by a lever worked from outside the apparatus.

Lastly, the photographs give a record of the middle pendulum (No. 2) alone; this is the lowest curve. This record is necessary for the computation of the amplitude reduction, as it is not possible to do this only from the upper curves representing the two pairs Nos. 1 and 2, and 2 and 3: for each pair one of the pendulums must also be recorded

apart, and this is furnished by the record of the middle pendulum. In order to get a curve with a straight axis, this is done, not by recording the angle between this pendulum and a fixed line in the apparatus, but between this pendulum and an auxiliary one, swinging in a parallel plane, but so strongly damped that oscillations are prevented.

It would take too long to enlarge upon all the details of the new apparatus, and so this will not be done. It has proved to be satisfactory. Firstly, the observations are much less troublesome than formerly, both to the observer and to the crew of the boat, for because of the suspension in gimbals bigger angular deviations of the boat may be tolerated, and so it is not necessary for everybody to keep still during the whole time of the observation.

Secondly, the records have fully confirmed the expectation that the ship's movement would be effectively eliminated; as the curves of the hypothetical pendulums are now themselves recorded, every irregularity resulting from an imperfect elimination would at once be detected. This has never been the case, although the number of observations has well-nigh reached two hundred; only once, during an observation at the surface of the sea, which was not quite calm, the ship's movements were too great, and the knife-edge of one of the pendulums slid on the agate plane. The irregularity of the movements of the middle pendulum, as shown by the lowest curve, gives a good idea of the magnitude of the disturbances eliminated in the upper curves.

Thirdly, the time required for the computation of an observation is much reduced. While it took two days for an observation made with the old apparatus, it is now no more than a few hours; in fact, it scarcely exceeds the time required for the computation of a land observation.

There is no doubt that with the new apparatus observations will also be possible on board ordinary ships when the sea is quiet. It will however be necessary to prevent all vibrations, so that this will involve for most ships the stopping of the engines during the whole observation.

For the probable errors of the observations only provisional figures can be given. It is not likely, however, that the final computations will alter them much. The probable error of the determination of the mean time of oscillation of a pair, arising from all the effects of the ship's movements, is only $2{\cdot}0\ 10^{-7}$ sec., giving 0·0008 cm. in g. This is a small amount, but there are some other errors coming in, which are more important. In the first place, there is the error caused by the uncertainty of the chronometer rate, which can now be estimated, as the time of oscillation may be computed with the two chronometers independently. The comparison of the two results gives a probable error in the result for g of 0·0018 cm. In this figure is not included the probable error resulting from errors in the reception of the radio time-signals, and in these signals themselves; but as an uncertainty of the rate of 0·01 sec. gives only 0·0002 cm. in g, it is not likely that this will amount to much.

Another additional error is caused by the effect of the east–west velocity of the ship on the centrifugal force of the Earth. As the velocity of the ship with regard to the water is known, this part of the velocity may be taken into account with sufficient accuracy; but the current also contributes to this effect, and this part is generally rather uncertain. To give an idea of the magnitude of this error I may say that a velocity of 1 mile gives a deviation of 0·0075 cm. at the equator. It is difficult to get an exact estimate of this error; in mid-ocean it will generally be less than near the coasts, as the current is more regular there, and I think it seldomly will exceed 0·002 cm. there. This error is of course independent of the method used to determine gravity at sea; it is inherent in all observations carried out on board ships.

Lastly, an error comes into the derived anomaly, because the latitude enters into the formula for the normal value of the gravity. During our voyage as many determinations of the ship's position were therefore made as were possible, and so in favourable conditions the position was known within a mile; but in many cases the uncertainty is greater. As however most of the stations were in low latitudes, where the normal gravity difference per mile is small, the probable error in the anomaly caused by this uncertainty of latitude is generally smaller than 0·002 cm. and often below 0·001 cm.

This uncertainty in the ship's position is also important in estimating the probable error in the topographic reductions for those stations which are near large topographic features. A second point regarding these errors is the imperfect knowledge of the topography of the sea-bottom in great parts of the oceans. In the Pacific, for instance, whole stretches are quite unknown, and I am able to communicate a striking example of the unexpected features which may still be hidden. West of Honolulu we found a large unknown ridge where the ocean depth is less than 1000 fathoms, and which has a horizontal extension in east–west direction of nearly 1000 miles.

For the right interpretation of the gravity results more soundings are highly desirable, and therefore it would be well if gravity observations at sea could always be accompanied by soundings. Even where the topography of the bottom is known it will be useful, because it may allow a better location of the observation with regard to the topographic features, especially where those features are irregular.

For the voyage of the *K XIII.* this subject was therefore put on the programme; by the courtesy of the Hydrographer of the British Navy, and the firm of Hughes & Co., we were able to take with us a first example of the deep-sea sounding gear designed by the Hydrographic Department, and executed by this firm. The hurry necessary for its delivery was however the cause of some difficulties with the apparatus, which probably could have been avoided if there had been more time. Besides, the ship being small, the sending and receiving apparatus

proved to be too near the wave-disturbance to permit soundings at the surface of the sea. During submergence, however, the depth could be got with sufficient accuracy, and so at each gravity station a sounding was taken. I hope it may be possible for ships of other navies to make some more soundings near our route, for in several cases a more complete knowledge of the sea-bottom topography would be very desirable for the reduction of my gravity values.

The soundings have left the general impression that the sea-bottom is more irregular than the charts indicate. This is especially the case for the eastern and middle part of our route through the Atlantic, and in the Pacific west of Honolulu.

The voyage of the *K XIII.* took 200 calendar days, from our sailing from Holland on May 27 till our arrival in Surabaya on December 13, but we saw the light only 199 times coming and going, because we jumped a day at the 180th degree of longitude. Happily there fell no birthday on this day, so that nobody had to solve the problem if in this case he really had got a year older. We had altogether 112 days at sea, and the remainder in the following harbours, which we touched: Horta (in the Azores), Las Palmas (in the Canaries), Curaçao, Colon, Panama, Mazatlan, San Francisco, Honolulu, Guam, Yap, Manila, Amboina, Banda, and Bima (on the island of Sumbawa). The biggest uninterrupted distances were those from Las Palmas to Curaçao and from Honolulu to Guam, which took us respectively seventeen to eighteen days, as our mileage was low in order to spare the engines. We were lucky in having generally good weather, although the sea was seldom quiet enough to allow the opening of the hatches in the main deck, which was not in favour of a good ventilation. We often had the wind following, and this caused us much additional heat and bad vapours from the exhaust gases.

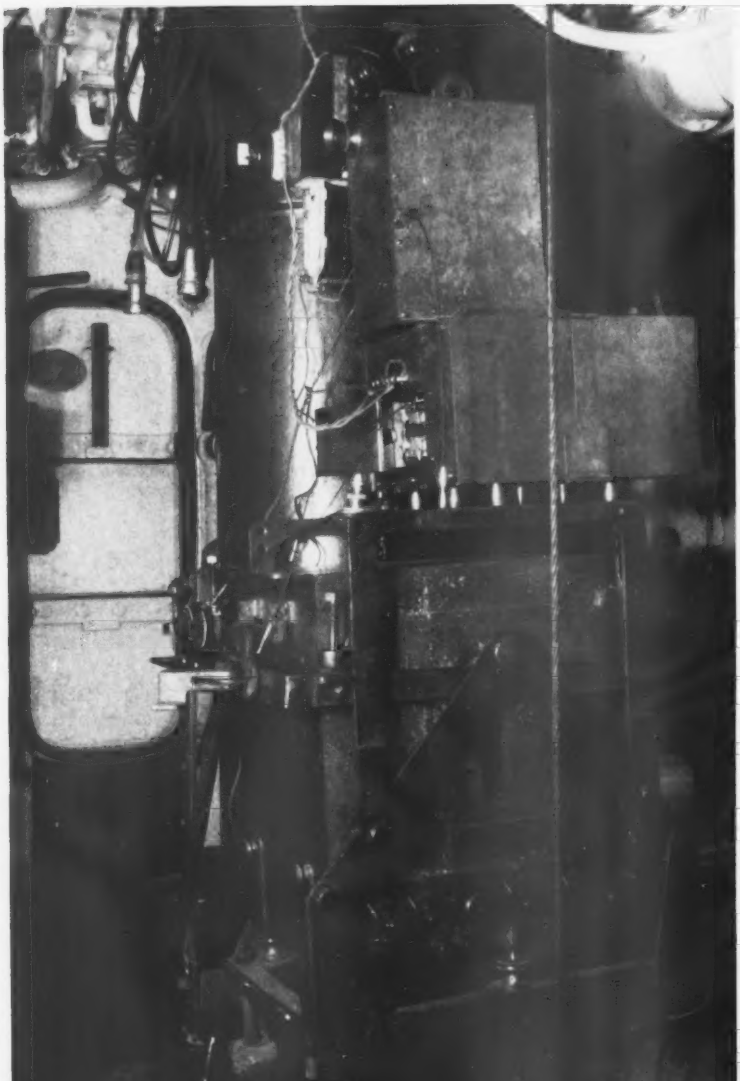
In the aggregate observations at 128 gravity stations were made, of which 15 were in harbours for control. Of the 113 observations at sea, 5 were made at the surface, so that we submerged 108 times during our voyage. During a subsequent smaller voyage of 12 days, executed in order to make a detailed gravity survey of the Java Deep, 26 new stations were observed, for which we submerged 24 times.

During the principal voyage we generally went down once a day, but where scientific interests made it desirable, more observations were made, and days with four submergences have occurred several times. Everybody knowing about submarine life in the tropics will agree that this means rather a serious aggravation of the voyage, and therefore I am happy to be able to say that notwithstanding this Commander van der Kun gave me all the opportunities I asked, and that officers and crew always took it entirely in the right spirit and gave their assistance in a most helpful way.

The Submarine K XIII in the Atlantic

Lying at Willemstadt, Curaçao

Passing through the Culebra Cut



Pendulum Apparatus mounted in gimbals in the Submarine K XIII

OF MICH.

During the first part of the voyage the radio time-signals of Bordeaux were taken and afterwards those of Annapolis, but for the crossing of the Pacific no good signals were available. The difficulty was solved by the co-operation of the Netherlands-Indian Topographical Service with the radio service of Malabar and the Bosscha Observatory at Lemborg on Java, by which a radio time service was arranged for the duration of the voyage. The signals were of the rhythmic type; we could already receive them at Curaçao.

The problems for which the voyage could give new data were:

1. *Investigation whether the longitude term in the formula for the normal value of gravity is justified.* This term was found by Helmert in 1915 and by Heiskanen in 1925 by treatment of the continental gravity determinations. It was thought that the complete ring of gravity observations made by the voyages of the *K II.* and the *K XIII.* would give valuable new material. For this purpose it was desirable that the voyage should be made in a low and not too variable latitude. For this reason the route across the Atlantic was chosen *via* the Canaries to the West Indies, and across the Pacific from San Francisco, where the ship had to dock, *via* Honolulu to Manila.

2. *The question whether the Earth's crust under the oceans is in isostatic equilibrium.*

3. *The investigation of gravity over the Mid-Atlantic ridge.* In order to get more data about this ridge than by once crossing it between Las Palmas and Curaçao, the route from Holland to the Canaries was chosen *via* the Azores.

4. *The investigation of gravity over the great ocean deeps.* Four deeps were crossed during our principal voyage: near Porto Rico, near Guam, near Yap, and near the Philippines. Moreover a detailed survey of the Java Deep was made during the subsequent shorter voyage.

5. *The investigation of gravity along the continental shelves.* A good opportunity was offered between Panama and San Francisco; besides a series of observations over the lower part of the continental slope, observations were made on four profiles perpendicular to the coast-line from deep sea to the 100-fathom line.

6. *The investigation of gravity in the eastern part of the Malay Archipelago,* where probably the Earth's crust is still in an unstable condition, so that large gravity anomalies may be expected. Sailing from Manila *via* the Strait of Manipa and Amboina to Banda, and then from Banda along Dammar towards the south to the Sahul shelf, the double island-arcs were twice crossed, and observations could be made at all critical points. From the Sahul shelf a course was taken round the north of Timor *via* the Flores Deep, where observations were made, towards Bima, and from there to Surabaya.

The results of the observations have not yet been finally computed; provisional computations have been made, but of course these results

Anomaly
+·200
·150
·100
+·050
·000
-·050
·100
·150
-·200
San Francisco
Panama
Sea Level Anomaly
With Isostatic Reduction
Profiles join at points 1 to 4.
Canaries
Porto Rico
Sea level
2500 m.
5000 m.
7500 m.
10000 m.
Depth
San Francisco
Honolulu
Philippines
Yap
Guam
Porto Rico Deep
Nero Deep
Yap Deep
Philippine Deep
on horizontal scale 4 times above
Profiles
on same horizontal scale as deeps

are only approximate, although it is not believed that the difference will be great. Besides they have not yet been checked. It must therefore be considered premature to draw any definite conclusions from these results. Another reason for this is that the topographic and isostatic reductions are not yet all computed. These reductions, which will give a clearer insight into the meaning of the results, are now being executed disinterestedly in the office of the U.S. Coast and Geodetic Survey; in the same way this office has already made similar calculations for the results of the voyages of the *K II.* and the *K XI.* I wish here to express my thanks to Dr. William Bowie and the other authorities of this service for this important contribution.

Although final conclusions are not yet possible or advisable, still some general impressions may be given, which most probably will not be changed by further consideration.

First of all it may be said that in both oceans an extensive positive anomaly is found. In the Atlantic the mean of 17 purely oceanic stations between the 15th and the 51st degree of longitude shows an anomaly of +0·025 cm. before, and of +0·040 cm. after isostatic reduction. In the Pacific the mean of fourteen similar stations between the 141st degree of longitude west of Greenwich and the 176th degree east of Greenwich gives +0·038 cm. before and +0·020 cm. after isostatic reduction. By purely oceanic stations those stations are understood, for which gravity is not disturbed by the neighbourhood of coasts and islands. West of this part of the Pacific there are a few stations with very small anomalies, but farther west, where we get into the region of the great deeps, positive anomalies are again found for all those stations which are not near the deeps themselves. Going westward these anomalies become more and more positive, and west of the Philippines we find even anomalies of more than +0·100 cm. after isostatic reduction.

This general tendency towards positive anomalies in the Atlantic and the Pacific is a curious thing. A small excess of gravity might perhaps be expected, as Bowie has remarked, even in the case of absolute isostatic equilibrium, because of the deviation between the geoid and the spheroid, caused by the corresponding distribution of mass. It can be shown that in case of perfect isostasy the geoid in the continents must be outside the spheroid, and over the oceans inside. As the gravity results, which are reduced to the geoid, must be reduced to the spheroid to make them comparable with the formula for the normal value of gravity, these distances must be taken into account, and a superficial investigation leaves the impression that accordingly the gravity values found over the oceans must be slightly in excess before that reduction is applied. It is not likely however that this excess will be more than some 0·006 cm., and there are even indications that a complete investigation of the matter will show that it is still smaller. It is not probable therefore that the positive anomalies which have been found can be wholly explained in

this way. This conclusion is confirmed by another investigation, which will presently be mentioned, which makes it probable that there are much greater deviations between the geoid and the spheroid, of a contrary sign, and that the gravity results in the oceans, after being reduced from the geoid to the spheroid, will be even more in excess than before this reduction.

The first question which arises is: Do these positive anomalies correspond to the longitude term of Heiskanen or Helmert? Before giving an answer, attention may be drawn to another point. This is that there are two reasons for expecting more regular gravity results and better isostasy in the oceans than in the continents. Local irregularities of mass are much farther from the observer, so that their disturbing influence must be smaller; and secondly, there is no erosion and only a very slight sedimentation in the oceans, so that one of the causes of equilibrium-disturbance in the Earth's crust is absent. It might have been possible, therefore, that in the oceans absolute isostasy should prevail, and in that case we might expect no isostatic anomaly at all, or an anomaly corresponding to a pure longitude-term. It is true that this term would also mean an equilibrium-disturbance, but it would be a deep-seated one, applying to the Earth as a whole and compatible with an Earth's crust partly or wholly in isostatic equilibrium. Neither of the two possibilities has been found: there are isostatic anomalies in the oceans, and they do not correspond to a pure longitude-term. When we take therefore the above question in this sense, the answer would be negative.

The gravity-results compel us to accept extensive disturbances of isostatic equilibrium, and it will be very difficult to decide if these are located only in the Earth's crust or whether there are also deep-seated disturbances. An absolute answer to this question is impossible, as there is an infinity of possible mass-distributions, which all correspond to the same gravity potential at the Earth's surface. But when gravity is better known over the whole Earth there may perhaps be an answer. When, for instance, the isostatic anomalies show some relation to the crust-formation it will be very probable that their causes are located in the Earth's crust, and that the Earth's interior is in equilibrium. When we require the formula for the normal value of the gravity to represent that, if the anomalies are zero, the Earth's crust is in isostatic equilibrium, this formula ought not in this case to have a longitude term.

The results of the voyage of the *K XIII.* give me the impression that the positive anomalies which have been found are inherent in the oceans, and if this should be true, it would point in the last direction. It is however only a superficial impression, and I doubt if, even after the computations and the reductions have been finished, a surer conclusion will be possible. For this it is necessary to get more gravity data over the whole Earth, and for that purpose the observations at sea will have the advantage of being less locally disturbed and therefore representative

of a greater area than the land observations. A few long crossings would soon give a much better insight.

Specially interesting would be a series of observations in the central or southern part of the Indian Ocean. The results found in the northern part of this ocean between Aden and Sabang during the voyage of the *K II.* in 1923 show almost no anomalies before the isostatic reduction, and decidedly negative anomalies for the central part of that stretch after this reduction. This would not be in harmony with the supposition that positive anomalies are inherent in all the oceans, and it would rather point to a confirmation of the longitude term. It is however doubtful whether these results can be considered as representative of the Indian Ocean, because of the vicinity of the Himalayas. Observations more to the south would give important data for this interesting problem.

Generally speaking, the fact that extensive deviations of isostasy have been found makes it still more desirable than it would otherwise be to continue the observations on as large a scale as possible. Only further investigation of these deviations can perhaps provide us with an explanation.

There is still another meaning possible for the above-mentioned question about the longitude-term: Do the results of the voyage give a longitude-term if they are expanded into series of spherical harmonics? Of course they will give longitude-terms then; they will give a term of the second order, which is the one which is under consideration, as well as terms of higher order. But this throws no light on their physical meaning. I will not go further into that question here, as I have not yet computed these terms for the provisional results which are now available.

The gravity data of the voyage have also given curious results in another line of investigation. It is well known that in the past century Stokes gave an important equation which allows of the computation of the figure of the Earth, *i.e.* of the geoid, when the gravity is known over the whole surface. For computing the distance between geoid and spheroid at a certain point along this line, we need indeed the gravity everywhere, but the gravity near the station has the greatest influence, and it is not necessary to know the gravity in the other parts in detail. To get an impression of the magnitude of the deviations between geoid and spheroid I have made a first trial in this direction by introducing into Stokes' formula the gravity values of the voyages of the *K II.* and of the *K XIII.*, making together a complete ring round the Earth, and supposing that these values are valid for a belt extending from 20° northern to 20° southern latitude. For the remainder of the Earth a zero anomaly was supposed.

These suppositions are of course quite imaginary, but they still may serve to give a first idea. As the extension of the anomalies in the east–west direction is great, an extension in the north–south direction of this magnitude seems acceptable. To avoid however giving an undue

extension to local anomalies, only the purely oceanic values have been used; all the values near coasts and islands and also the values found in the western part of the Pacific, where the deeps may indicate local disturbances, have been left out.

The computation has been made with the unreduced results as well as with the results after isostatic reduction. Of course this last computation does not give the same geoid as the first one, but the geoid of a theoretical Earth without the actual topography and its isostatic compensation. Their difference is about the same as the deviation between geoid and spheroid in case of absolute isostasy over the whole Earth; it will not exceed 25 metres.

The results of these computations have been rather surprising. For the first computation, based on the unreduced anomalies, the distance between geoid and spheroid varies between +150 metres and −70 metres, and for the second one with the isostatic anomalies between +180 metres and −50 metres. For both computations the distance is generally positive for the two oceans, the Atlantic and the Pacific; that is to say, the geoid is there outside the spheroid, and the distance is of the order of magnitude of some 100 metres.

These deviations are bigger than might have been expected. About their character it is not possible to say much, as the before-mentioned suppositions are too uncertain. They make the impression of being related to the crust-formation, *i.e.* to the distribution of oceans and continents, but they may also be caused by an elliptic form of the equator and the parallels, combined with more local deviations. It is the same problem as has been mentioned before in speaking of the anomalies, and only more observations can throw light upon it.

It seems not probable that further observations will give another view about the order of magnitude of the deviations, and so I think it will be necessary to accept the existence of these deviations of some hundred metres. This is an important fact, which has of course a profound bearing on several problems. A first conclusion is that the flattening of the Earth is not a single figure and is dependent on the position of the equatorial radius to which it has reference. The different values must show discrepancies of several units in the denominator. A mean flattening can be determined only by astronomical methods or by a complete knowledge of the whole geoid, and the only way to get this will be a gravity survey over the whole Earth and the application of the formula of Stokes.

Measurements of arcs can give only the local shape of the geoid; they will never allow an exact conclusion about the figure of the whole Earth. Discrepancies between measurements of arc in different places are unavoidable, and there is no need to attribute them to errors of observation. These conclusions are quite in harmony with the suggestions made by the secretary of the R.G.S., Mr. Arthur R. Hinks, in his

study on the figure of the Earth, presented to the Society in March of this year. The gravity results of the voyage of the *K XIII.* give a strong support to these suppositions.

The magnitude of the deviations between geoid and spheroid has a further consequence. It makes that the reduction of the gravity values from geoid to spheroid, necessary for making them comparable to the formula for the normal gravity, is not negligible. A rigorous determination of the gravity anomalies will therefore not be possible before the geoid is known. This is a new reason to hope that the gravity survey, which allows its determination, will be continued energetically.

I will now with a few words give some impressions about the bearing of the results on other problems. As they have a more local character, it is still more necessary to be careful and to await the final computations and reductions before drawing definite conclusions.

The observations above and near the Porto Rico deep give the impression that this deep is wholly or for a great part uncompensated. For the deeps near Guam, Yap and the Philippines the results are less clear on this point. A profounder study will be wanted before giving an opinion. With regard to these last deeps in the western part of the Pacific, the results show the remarkable fact that there are positive anomalies in that whole region except above the deeps themselves, where the anomalies are strongly negative. It appears somewhat difficult to bring this result into harmony with the conception of the deeps being caused by a wake-effect behind islands, moving in a westerly direction.

In the eastern part of the Malay Archipelago big anomalies have been found, positive as well as negative, and even after isostatic reduction there are anomalies of several hundreds of the third decimal place in cms. This is not surprising for this mobile part of the Earth's crust, but the distribution of the anomalies is curious. Further study will be necessary before any explanation can be proposed.

The observations along the coast between Panama and San Francisco have given a systematic but unexpected result. Over the bottom of the slope there is everywhere a decided positive anomaly, while over the upper end there is no appreciable anomaly or even a negative one. An explanation of this effect, which will surely not disappear in the final computations, seems not easy. It will be of great interest to investigate other coasts to see whether it is a general feature or whether it is only present at the west coast of Central and North America. Important results might be expected.

It would be premature to go further into details about the results of the voyage in this provisional communication. I wish to finish by expressing my thanks to the Netherlands Navy and the Netherlands Geodetic Commission for enabling me to carry on this research on such

a large scale, and to the officers and the crew for the assistance given throughout those seven months that I have been their companion on board of the *K XIII*.

DESCRIPTION OF RECORDS OPPOSITE

The upper band is the record of pendulums 1 *and* 2 *combined; the middle band of* 2 *and* 3 *combined; the lower band of pendulum* 2 *alone.*

The firm line near the middle records the temperature of the air in the pendulum case: in the Mid-Atlantic record the trace is broadened by elastic deformation due to vibration.

The pendulum trace superposed in the middle is that of the damped pendulum in plane perpendicular to the others, which gives the inclination of their plane of oscillation.

The record is interrupted at half-second intervals by two chronometers, sidereal and mean time. Thus each chronometer produces two sine curves on each record, each curve formed by interruptions at intervals of one second. The steeper curves are formed by the sidereal, the gentler by the mean-time chronometer. The irregularities in the time-mark curves of the Mid-Atlantic record are due to vertical accelerations of the submarine.

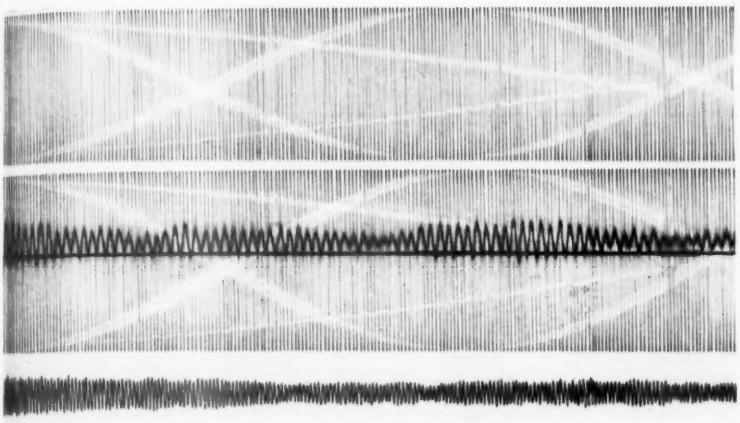
DISCUSSION

Before the paper the CHAIRMAN (Col. Sir CHARLES CLOSE) said: This afternoon we are going to listen to a paper which will be read by Dr. Vening Meinesz on his remarkable voyage in a submarine from Holland, through the Panama Canal and on to Java. It is the second voyage of the kind he has made and the second time he has addressed this Society. There is an immense amount of interest in his method, and he has a great deal of new material to put before us in the course of his lecture, which I will ask him to begin at once.

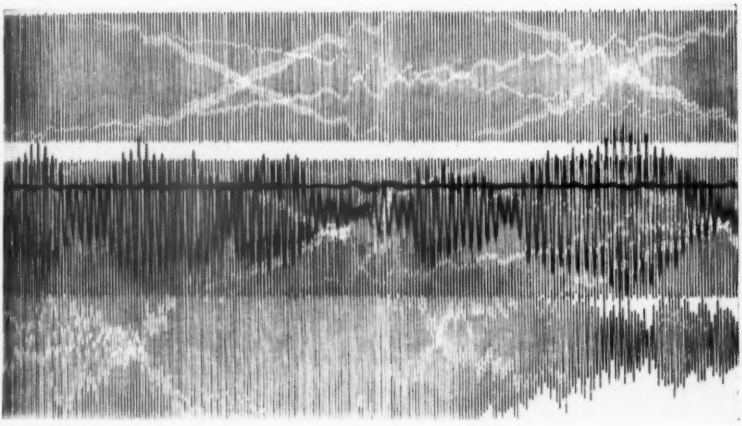
Dr. Vening Meinesz then read the paper printed above, and a discussion followed.

The ASTRONOMER ROYAL (Sir FRANK DYSON): I should like to say how much I was impressed by the beautiful dynamical principle Dr. Meinesz used in his apparatus. It seems to me that he must have commenced with a very interesting piece of theoretical dynamics and then embodied that in an extraordinarily beautiful and skilful apparatus. The slides showing the constancy of amplitude of the hypothetical differential pendulum were extremely beautiful, and we must all have admired the way in which every possible source of error was provided for, and the fact that everything was put on to one photographic sheet.

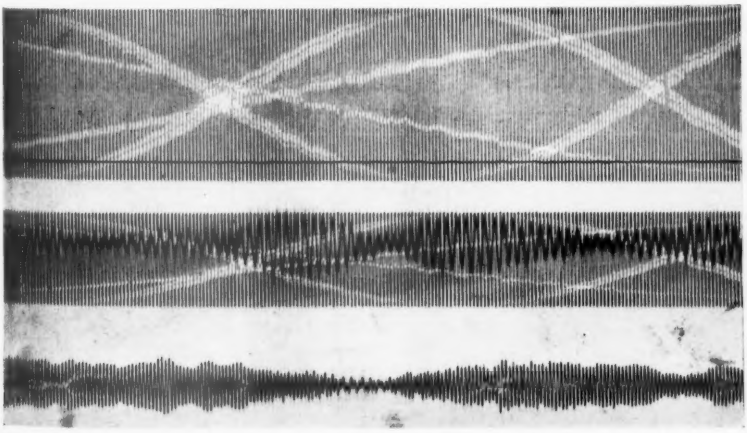
The subject is one about which I know very little, but it seems to me that Dr. Meinesz went on a veritable voyage of discovery; he certainly did find a series of most interesting results and some of them very unexpected. The difference in the geoid, worked out from the gravity by the formula of Stokes, in the Pacific and Atlantic oceans as compared with that of the spheroid seemed to me remarkable. The observations are hardly sufficient to enable one to be quite certain, but it seems extremely probable that they indicate a really con-



14 *June* 1926. *Las Palmas*



25 *June* 1926. *Mid-Atlantic*



10 *August* 1926. *Mazatlan Harbour, Mexico*

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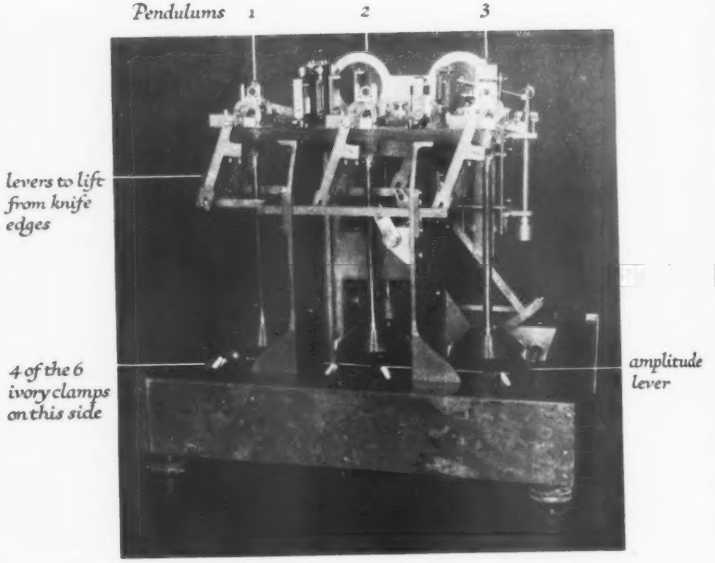
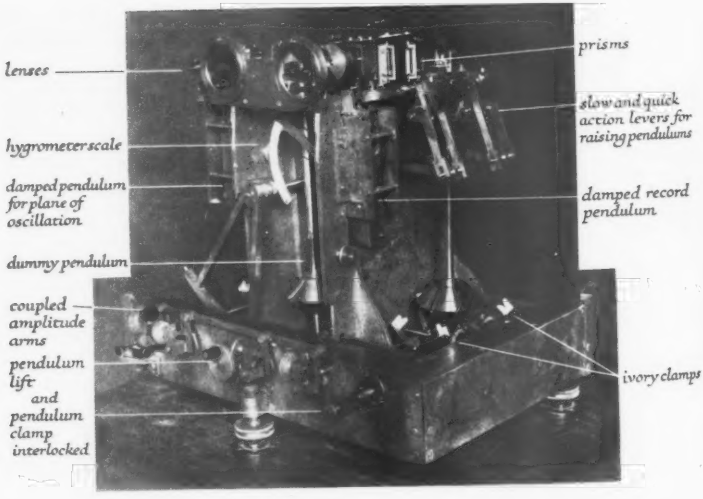

Pendulums 1 2 3
levers to lift from knife edges
4 of the 6 ivory clamps on this side
amplitude lever


lenses
hygrometer scale
damped pendulum for plane of oscillation
dummy pendulum
coupled amplitude arms
pendulum lift and pendulum clamp interlocked
prisms
slow and quick action levers for raising pendulums
damped record pendulum
ivory clamps

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crete addition to the study of the Figure of the Earth. I have listened to the lecture with the very greatest of pleasure.

Col. Sir GERALD LENOX-CONYNGHAM: I would like to endorse what the Astronomer Royal has said of our admiration for Dr. Meinesz's achievement: firstly, of his powerful theoretical analysis of the principles involved, then of his ingenuity in designing the apparatus, and lastly of his courage as a much-enduring voyager. It is seldom that we have combined in one person so many qualities.

In the results, of which Dr. Meinesz has told us to-day, there are three features which seem to me of special importance. First, he drew attention to the fact that if by the use of a series of spherical harmonics you produce an agreement between the values derived from the formula and those obtained by observation, you are thereby, most likely, masking the departures from equilibrium which you are in reality trying to find out. It is, therefore, undesirable to use any formula which departs from what is physically explicable; and therefore to use a formula containing a longitude-term is a mistake. As he well says, we require a formula for the normal value of gravity to represent the value of gravity when the Earth's crust is in isostatic equilibrium. An anomaly should be an indication of departure from equilibrium and therefore of physical strain. That seems to me to be a valuable consideration.

I was also interested in what he said about the flattening of the spheroid on different meridians being probably not the same. That seems to be rather at variance with what I have just said as to not using a longitude-term, but the two things are not really inconsistent though I will not go further into that at this moment.

There has been a good deal of controversy at one time and another as to what is the true value of the flattening, and it rather appears as if the flattening were like our friend the chameleon in the well-known story which some thought one colour and some another, and which eventually proved to have changed colour when passing from one observer to another. So it is possible that the different values of the flattening which have been found have all been true enough, and that its value varies from one meridian to another.

Thirdly—and I think this is not the least important result of what we have heard this afternoon—it would be not too much to say that there were a good number of geodesists in the world who expected that if and when gravity became measurable on the ocean we should find that there was little, if any, departure from complete isostatic equilibrium, and if Dr. Vening Meinesz's observations had shown that all round the ocean the formula gave results which differed but slightly from the truth, there would have been a strong tendency to say that the matter was now settled, that the theory of isostatic compensation gives all we can require to know about the value of gravity at a given point, and that observation might now be dropped. But Dr. Meinesz's results show very clearly that this is not the state of things: that there are, in fact, great deviations from simple isostatic equilibrium, and that the matter deserves and should receive much more extensive investigation. One generally finds in the investigation of natural phenomena that the deeper one goes the less one has got to the bottom, and I think this a particularly good example of the truth of that principle.

The CHAIRMAN: Dr. Meinesz mentioned Mr. Hinks' recent paper; perhaps Mr. Hinks will say a word or two.

Mr. HINKS: I think the meeting will agree with me that I was right in assuring Dr. Meinesz, when I met him in Praha some months ago, that this

Society would be anxious to hear of his results at the earliest possible opportunity.

There are only two remarks which at this hour I should wish to make. First of all, the fascinating part of Dr. Meinesz' discovered method, as it seems to me, is that it removes a grave physical disability from which we have suffered on this Earth: that the two Hemispheres are so extremely unlike. The mathematician does not distinguish between the northern and southern hemispheres in his value of the Figure of the Earth, but I think the geographer is bound to. There is in the northern hemisphere most of the land but a 10,000-feet deep ocean at the North Pole. There is in the southern hemisphere nearly all sea but a 10,000-feet plateau at the South Pole. Now in these circumstances it needs a good deal of faith to believe that it does not matter when you make an observation whether the sign of its latitude is positive or negative, and there is not enough land in the southern hemisphere to enable the ordinary geodetic methods to go very far into the question. Therefore, we are all particularly grateful to Dr. Meinisz for having provided a method of studying the variation of gravity and therefore the variation of the ellipticity of the Earth, which in the southern hemisphere in particular will be of a value quite impossible to estimate, because it will be, as far as we can see, a unique method. That, I think, is why in particular his somewhat recondite and very beautiful investigations ought to appeal especially to the geographer, for no geographer would ever really feel happy with a theory which started off with the *a priori* assumption that the two hemispheres should be treated as of the same value.

One more word, if I may say it, Sir. At the meeting of the International Geodetic Union at Praha the Section of Geodesy heard Dr. Meinesz, and had the great pleasure of seeing the apparatus he very kindly brought there. At the invitation of its President, Dr. William Bowie, who spoke most warmly on the subject, the Section passed a resolution expressing their high opinion of the importance of this work, and urging that the Governments of the world, especially those which had strong submarine services, should as soon as possible follow the admirable example set to the scientific world by Dr. Meinesz and by the submarine service of the Netherlands. Now those of us who attend scientific congresses are familiar with the fact that sometimes pious resolutions are passed at the extreme end of a meeting without any very serious consideration; therefore some resolutions of International Congresses have more weight than others. I should like to emphasize the fact that this was no pious resolution tacked on without due consideration. It was a very formal pronouncement by the International Geodetic Union in its Section of Geodesy, a pronouncement that Dr. William Bowie was most anxious should be brought really seriously to the notice of Governments. That is the point I should like to make about the resolution passed at Praha.

Mr. F. J. W. WHIPPLE: I should like to ask one question, and that is with regard to isostatic compensation, because, not being familiar with the detail, I find it difficult to realize what is the exact assumption which is made. Is there some definite assumption as to the amount of Sima at the bottom of the ocean and as to its specific gravity? If the ocean had underneath it rock of a greater density than was assumed in this calculation, would the anomaly be explained away? Is that a possible interpretation of the anomaly—not that there is an unexpected departure from sphericity in the globe, but an unexpected departure from uniformity in the weight of the strata?

Dr. VENING MEINESZ: First as to the last point, whether the deviation of the geoid from the spheroid, which seems to be shown by the introduction into

the values of the Stokes equation, is quite independent of isostasy or not. You find the gravity of the Earth and from that gravity deduce the geoid, the geoid being the potential plane of gravity ; this is simply based on a potential theorem and has nothing to do with how the gravity is caused, but the fact that there is such gravity gives such and such a geoid. We can therefore consider that quite apart from any hypothesis as to isostasy.

With regard to the question as to whether the positive anomalies of the ocean could be explained without accepting any departure of equilibrium : they are now reduced by accepting the assumption of Hayford that compensation is distributed in a layer quite regular and about 110 kilometres deep. This may not be the actual fact ; it may be that the situation is quite different. Thus we have to rearrange that compensating effect of mass in quite another configuration. But although by rearranging it is possible to change the outline the total over a large part remains the same. It is possible that *e.g.* the curve of the coast effects changes, but the integral, the mean, of the reduced anomaly remains the same. That only depends upon the total mass. Therefore if we know the mean anomaly over the whole ocean to be positive this mean value will remain absolutely the same after reduction whether you adopt the Hayford theory or any other theory of isostatic compensation. The voyage of the *K XIII.* has only given the mean over a line crossing the oceans, and so another theory of isostatic compensation may indeed slightly affect this mean positive value, but a systematic disappearance of the excess is quite out of the question.

The CHAIRMAN : You will agree with me that we have listened to a very important lecture, and we are very much indebted to Dr. Meinesz, not only for giving us this lecture but for being so kind as to give us a summary of the results, which I believe we are almost the first to receive : a summary which gives us much reason for thought. Geodesists will ponder over this lecture when they read it. The whole method is one which is relatively new, and we feel that we owe a vote of thanks not only to Dr. Meinesz for all he has done for us and the Society by giving this information, but also to the Netherlands Government who spent the money and allowed a ship of war to go and carry out this scientific work. It is an example which can be followed elsewhere. I beg in your name and in the name of the Society to thank Dr. Meinesz for his lecture.

FLIGHTS NORTH OF POINT BARROW: *An Extract from the Report on the Detroit News–Wilkins Expedition of* 1927 *by* GEORGE H. WILKINS

IT was in December 1925 I proposed to explore by airplane, during the following March and April, the unknown region of the Arctic neighbouring Point Barrow, and if, or when, this work was done to attempt a flight from Barrow to Spitsbergen.

With the help of Mr. Stefansson, the American Geographical Society, The North American Newspaper Alliance, The Detroit Aviation Society, and the Detroit citizens, The Detroit Arctic Expedition was launched and entered the field in Alaska in February 1926. The expedition was in two sections: One section, as an auxiliary, was to endeavour by using snow motors to deliver gasoline and wireless supplies at Barrow. This section, after suffering much hardship, failed to reach Barrow with any useful amount of equipment. The airplane section, under my immediate command, was equipped with one tri-motored 72-foot Fokker monoplane and one Liberty-motored 63-foot Fokker monoplane—both fitted with wheeled landing gear and special navigation instruments. This equipment was shipped from New York to Fairbanks, Alaska, where it was assembled for flight.

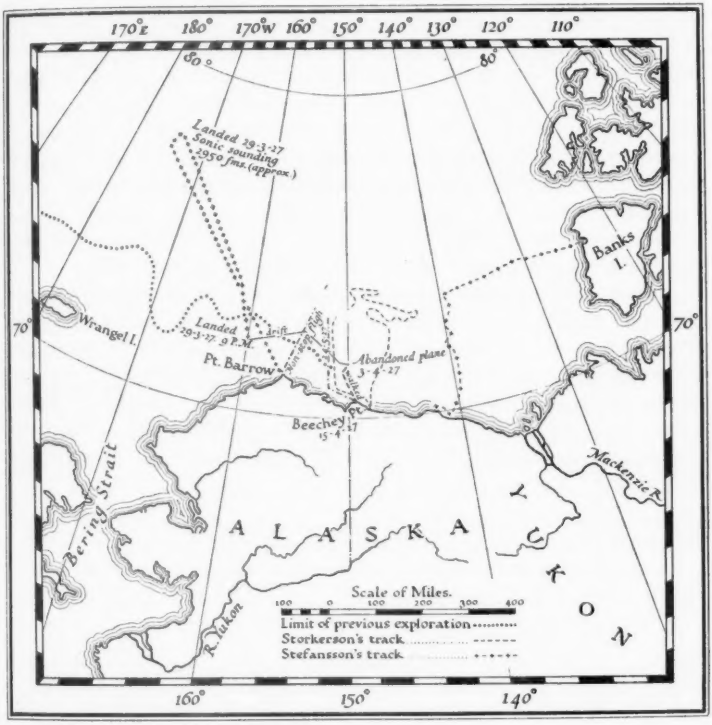
From the beginning of trial flights disaster dogged the expedition. Most unusual snow conditions necessitated much work to clear a landing field. A member of the expedition accidentally came in contact with a propeller and was killed instantly. The pilots had been selected with care and had the full recommendation of the U.S. Air Service of which they were officers. On attempting a landing on the first flight, with the Liberty-engined machine, the plane was wrecked. Just twenty-four hours later the tri-motored machine was wrecked, also in an attempt to land. The season favourable for Arctic exploration by airplane had passed before the machines could be reconditioned.

Later, the writer with Lieut. Carl B. Eielson as pilot, flew four times to Point Barrow to dump supplies and back, and once out over the Arctic Ocean 120 miles north of Point Barrow, observing some hundred miles into the unknown Arctic Sea. Another flight was made with the tri-motored machine, but thick fog prevented the continuation of the flight over the Arctic Sea. The expedition had covered approximately 8000 miles before it was postponed until 1927. Then, under the name of the Detroit News–Wilkins Expedition, it again flew into the Arctic with one 73-foot Fokker, powered with a Liberty motor, and two Stinson cabin-biplanes, powered with Wright Whirlwind motors. These machines were accompanied by one commercial Swallow biplane with an open cockpit. The machines in 1927 were fitted with skis.

Detailed plans for exploration depended on weather conditions experienced at Barrow, and when, at 6 a.m. on March 29, conditions

appeared to favour a flight to the west of Barrow, the writer, with Lieut. Eielson as pilot, set out in a Stinson biplane expecting to follow a course toward 78° N. lat. in long. 180°, to land and if possible take soundings at that point; and if indications of land in the vicinity were not found, to fly south for two hours, land, take another sounding, and return to Barrow.

As we left Barrow and headed for the ice we were at an altitude of 1000 feet; our ground speed was almost 100 geographical miles an hour;



the temperature on the ground was −42° F.; in the air at 1000 feet the same thermometer registered −32°; in the cabin of the machine it was 18°. The temperature varied both in the cabin and in free air during the flight, but it was at all times comfortable in the cabin.

From 6 a.m. until 10.20 we passed smoothly over the ice, in which we observed cracks and a few open leads of water. At times the ice was partly obscured by thin cloud and haze; a few bands of solid cloud were passed; but in general, during the outward flight, the weather was clear. Many patches of smooth ice suitable for landing fields were observed.

Between 10.20 and 10.30 the engine showed signs of trouble. Far ahead the ice looked old and much ridged. It appeared as if we were approaching an area of greater disturbance and pressure: appearances that led me to believe that we might be over shallow water. But that was not so; the ridged ice probably had drifted to that position.

Opposite 10.50 my log book indicates: Engine kicking all the time. Took bearing for drift. Wind now S.E. about 12 m.p.h. Will turn toward young ice patch in case engine goes wrong. By 11.10 the engine was so bad that we were compelled to land. By 11.15 we were on the ice. The ice beneath us was dull grey and flat, without ridges or snow-drifts. Beautiful flower-like crystals, 2 inches high, sharp and brittle as steel in the temperature of 30° below zero, covered the surface and cut into our duralumin skis.

The plane came to a rest quickly. My first thought was to take a sounding. Eielson hurried to examine the engine. To make a hole through the ice 3 feet thick, with an icepick, took eight minutes; then the icepick broke. I mended it with some screws from the cabin of the plane and a second hole some 30 yards away took slightly more time. Two holes were necessary for the Sonic sounding apparatus.

Eielson left the engine to detonate a charge. There was a 7·3 seconds interval between the detonation and the echo. Rapid calculation gave over 5400 metres as the depth. With the engine running I might have been mistaken. The engine was stopped. Eielson fitted the receivers to his ears. I completed the electric circuit and detonated a charge. Eielson announced 7·25. One of our regrets at the time was the fact that the clouds covered the horizon and it was impossible to get a sight of the sun for accurate position.

Our estimate of the position reached—lat. 77° 45′ N., long. 175° W.—is considered to be within 20 miles, and was determined as follows:

Point of Departure.—Cape Smythe Whaling and Trading Station, 7 miles south of Point Barrow sand-pit.

Destination.—Lat. 80° N., long. 180°.

True course 329°. Declination varying from 29° to 31° East. Deviation 5° on a north-westerly course. Correction applied for drift varied from +7° to −1°. Wind velocity varied from 8 to 15 miles an hour. Wind direction changed from north-east to south-east. Air speed recorded varied between 90 and 110 knots. Time of flight on direct course 4 hours 50 minutes. Slow flight with engine missing on northerly course, 22 minutes' circling until heading south-east into the wind for a landing, 3 minutes.

An observation of the sun with a bubble sextant at $10^h\ 18^m\ 30^s$, 150th meridian time, placed us near the line of flight. After that the sun was obscured and no sights were available.

In less than thirty minutes we were both at work on the engine. For two hours we fiddled and sought for the trouble, starting and stopping the engine to keep it warm. Then cowling and carburettor had to come off: nippy work on fingers at 30° below zero. Assembled again, the

engine gave 1400 revolutions per minute. This was not as it should be, but we thought it might take us off, and after five attempts we rose from the ice and headed for Barrow.

At work on the engine we had failed to notice the increasing wind and the lowering clouds. Once in the air we were enveloped in haze. Ten minutes later the engine started kicking and stalling again. There was nothing to do but land. Three times we approached the ice before being certain of a safe landing field. The sun was darkly obscured and visibility poor. The third time we were forced to land, fortunately on smooth ice. It was undoubtedly my actual experience on foot on the ice that enabled me to detect the unsuitable surfaces for landing. The surface on which we did land had looked good from the air, but in the hazy lights I could not have sworn to this until we came within a few feet of the surface.

The engine seemed to be getting very poor magneto service, and upon landing the second time the ignition was thoroughly overhauled. To do this it was again necessary to remove the cowling. The increased wind stiffened our fingers and the oil in the engine. Eielson—unknown to me—worked during this interval with four of his finger-tips frozen solid. He was to suffer permanent injury from this later on. When we finally reached Barrow the first and second phalanges of the fifth finger on the left hand were amputated.

After an hour's rapid and painful work it took many turns to start the motor, but once started it emitted a steady roar that gladdened our hearts. A very light snow had been falling, and as we taxied into the wind the freshly drifted snow made the surface sticky, and the first attempt to get off failed. The second time following our tracks gave us greater speed and we unstuck from the ice a few feet from the end of the flat surface.

What with the engine trouble, loss of time and gasoline, and the storm, it was considered inadvisable to proceed south, and at 2 p.m. we turned back towards Barrow. At 6 p.m. a ground observation showed a wind of about 40 miles per hour. Our indicated air speed was 95 m.p.h.; our ground speed registered 60 to 65 m.p.h. By 6.15 the sun and ice were almost entirely obscured. By 7 p.m. ground observations were no longer possible.

It was too risky to attempt a landing. By keeping on we expected to just reach the coast before our fuel supply gave out. Our position was above one of the most dangerous districts in the Arctic ice. A wrecked, forced landing within 100 miles of Barrow, in ordinary circumstances, would mean that our best chance of safety lay in a 300-mile walk to Wrangel Island. Visibility ahead was nil. We had climbed to 5000 feet. A dull glow through the clouds, like a clouded moon on a winter's night, showed where the sun was skimming beneath the far horizon. My watch was before me. At 9.02 the engine cut out suddenly, as if the switch had been snapped. There was no sputter or gasp because of starved car-

burettor, but a sudden silence, except for the hum of the wind in the wires.

Eielson snapped the switch right and left; there was no response from the engine. We could feel the sag of the falling plane. With great coolness and skill Eielson steadied the machine, righting her to an even keel and an easy glide. His eyes were glued to the turn and bank indicator. My hands were ready to guide and keep the compass course. As we came within a few hundred feet of the ground the horizon neared and we could dimly see it serrated with ice ridges, but they gave us no idea of the height or distance.

Near the ground the air was rough. The plane swerved and pitched, but Eielson, still calm and cool, corrected with controls each unsteady move. In a moment we were in the snowdrift. We could not see beyond the windows of the plane. I felt Ben brace himself against the empty gas tank; I leaned with my back against the partition wall of the cabin and waited: the left wing and the skis struck simultaneously. We bounced and alighted as smoothly as if on the best prepared landing field. I gripped Eielson's shoulder and slipped through the door of the machine to the ice. Wind and driving snow filled my eyes. Dimly about us I saw pressure ridges as high as the machine. We had, undoubtedly, struck one as we came down. Along the extreme edge of the lower wing the fabric was torn. The machine still rested on the skis, but the skis had turned on their sides, the stanchions twisted and broken. It was too dark to see well and the snow-drift too thick for close examination of our machine or position. We climbed back into the cabin and made ourselves comfortable for the night.

I had little faith in our wireless apparatus as the antenna current meter failed to register. But we repeated the short clipped message: "Went out 550 miles. Landed out of gas 65 miles N.W. of Barrow." These messages were never received.

The next morning I cut a hole through the ice and found we were drifting to the north of east at a speed of 5 or 6 miles an hour.

Our estimated position of landing on return journey—lat. 72° 15′ N., long. 159° 30′ W.—is considered to be within 20 miles.

Point of Departure for return journey—lat. 77° 45′ N., long. 175° W. Destination, lat. 71° 20′ N., long. 156° 30′ W.

True course 133°. Declination varying from 29° to 30° East. Deviation 0°. Correction applied for drift and pilot's error varied from +1 to +29. Wind velocity varied from 15 m.p.h. to 40 m.p.h. Wind direction varied from south-east to south-west. Observed ground speed varied from 60 to 75 knots. After 6 p.m. with compass in machine set at 130° and when the ground speed was not obtainable, ground speed was probably less than 60 knots.

Time of flight 7 hours 10 minutes.

Observed drift of ice at 11 a.m. Barrow local time March 30 showed a drift of 5 to 6 miles an hour. Having drifted for thirteen hours, the continued drift for a further 6½ hours would place us approximately in the position—lat. 72° 30′ N., long. 154° 45′ W.—established by observation of the sun on March 30.

We wirelessed: "Now about 100 miles north-east of Barrow. Accurate position to-morrow, if possible."

We had ten pounds of biscuit; twenty pounds of chocolate; five pounds of Army emergency ration, and about three pounds of mixed biscuit, chocolate, and pemmican. Fuel was our greatest concern. By draining our five tanks we collected a little more than half a gallon of gasoline. I was certain of getting both food and fuel on the ice if necessary, but to live by hunting on the ice takes time and patience. In order to save gasoline, we made a stove with a gallon can, and in this we burned engine lubricating oil, using two slats of wood from the cabin roof as wicks. The biscuits, pemmican, and chocolate were eaten cold.

For four days after we landed the blizzard continued, and travel over the sea-ice was out of the question. We were comfortably housed in the cabin of our plane, and we passed the time by improvising sleds with parts of the plane which in no way interfered with its airworthiness. Apart from the skis it was in first-class condition. The torn fabric would not have interfered with it in flight. With a little ingenuity the skis might have been fitted in a manner to enable us to take off, if gasoline were available.

On March 31, two fair sights at the sun fixed our position as approximately lat. 71° 50′ N., long. 151° W. Our drift was then tending south of east. Other observations on April 2 placed us at lat. 71° 45′ N., long. 150° W. By Sunday, April 3, the snow-drift had settled. There was little chance that our wireless messages had been received, and we decided to walk to the traders' post at Beechey Point, about 100 statute miles almost directly south.

For three days we dragged our sleds over an unbroken floe, but unaccustomed as we were to walking and hard labour, we travelled but a very few miles each day. It was necessary to camp early, because Eielson, when working on the engine the first day out, had frozen several of his fingers. Three on one hand and two on the other were giving serious trouble, which meant that I had to do practically all the work in connection with building the snow houses in which we slept at night. Two men can build a snow-house for themselves in less than an hour, but it takes one man alone a much longer time.

After three days' travel we came to a lead, and discovered that while the floe on which we were travelling was moving to the east, the one nearer shore was travelling to the west. For five days after leaving the plane we laboriously hauled our sleds over the old rough pack-ice, and then we came to ice the character of which assured me that it was land-locked, moving off and on shore, but not far to the east or west. Two good sun observations gave us our position lat. 71° 35′ N., long. 150° 40′ W.

Our progress shoreward with the sleds had been slow, so we decided to abandon the sleds and carry our load on our backs. I had provided packs, such as are used by the Indians of Canada, and while my load at

the start—and Eielson's not much less—weighed 120 pounds, we made much faster progress by climbing and crawling over the ice than we could have made with the sled. To have prepared the way for any type of sled, over the ice we traversed, would have meant hours of road-making.

Many times we were halted by leads of open water, but by waiting an hour or so or following the edge of the lead we managed to cross. Twice while attempting to cross ice too thin to bear my weight I went through and into the water, but an outstretched icepick prevented me from going completely under. We took these risks on young ice because of Eielson's frozen fingers, which had begun to give him trouble. We had a surgical kit, but I did not care to amputate his finger while still on the ice.

Eighteen days after we had landed on the ice we sighted, from several miles off shore, the low tundra on the Arctic coast-line, and three degrees to the right of the course we were making we could see the roof of a house. It was the trader's store at Beechey Point for which we had set our course when we left the plane. In a little more than two hours after we sighted the house we were eating our first hot meal in eighteen days. We had started with thirty-eight pounds of food and half a gallon of fuel. We had, when we came ashore, five pounds of food and half of our fuel. This showed an average consumption of less than sixteen ounces of food per man per day. Yet we had not apportioned or rationed our food. Each one ate as much or as little as he chose. We had frequently crossed very fresh bear tracks and had seen several foxes and seal, although we were not looking for them. We were confident at all times that, if necessary, we could have obtained a living by hunting on the sea-ice; but we did not care to delay for this when we had ample food in our packs.

Three hours after we reached the coast an Eskimo with his dog team was speeding to Point Barrow with a message to the expedition headquarters, and a week later the second Stinson biplane called for us and took us back to Barrow.

We then intended to use the Fokker machine for a flight over the ice toward Greenland, but experienced some delay in obtaining a propeller suitable for the job. After two weeks we finally decided to set out with the second Stinson plane. Before this machine was ready fog had rolled over the Arctic Ocean, and several short flights to observe conditions showed that nothing could be seen from the air of the Arctic Sea near Barrow. One day, when conditions seemed more promising, we went for 200 miles over the fog towards Greenland. The fog was 2000 feet thick beneath us: above was a thick layer of cloud obscuring the sun.

We should have served no useful purpose by continuing over the hidden Arctic Sea, so we returned to Barrow, and postponed our efforts until the winter of 1928, when we hope, by flying from Barrow towards Grant Land and continuing on to Spitsbergen, taking two or more soundings *en route*, to complete our original plans.

NOTES ON ARCTIC FLYING: *Extracted from an Appendix prepared for a forthcoming translation of the 'Northward Course of Empire' communicated to the Society by*

VILHJALMUR STEFANSSON

PRACTICALLY the only arctic flights of 1927 were by the Detroit News–Wilkins Arctic Expedition, for little of the extensive commercial flying in Alaska was in the Arctic section of that territory; most of it was in the temperate zone. Neither the scientific world nor Wilkins himself expected many or important contributions to our knowledge of arctic air conditions. Such knowledge can only derive from the slow accumulation of statistics gathered on scores or hundreds of flights, for the storms or calms or other conditions you meet on any one, two, or three flights may be only exceptions to a rule. But there was the landing problem still in grave dispute. Was it correct that the only landing places at sea were the leads, with the corollaries that the only suitable flying season was summer and the only suitable planes flying boats? Or was the opposite correct, as Wilkins and a few others still maintained, that there was scarcely ever a 5-mile stretch of the moving pack far from land where you could not make a reasonably safe landing with skids? This was a crucial debate. If the former were right the Arctic, in spite of its generally favourable air conditions, would be one of the most dangerous flying areas of the world for aeroplanes, because of the absence of landing places. If Wilkins were right the Arctic, because of combining particularly good air conditions with a greater frequency of suitable natural landing places than almost any other part of the Earth, would be a great natural theatre for the development of heavier-than-air flying, since there are many large population centres which are near each other if you can fly straight between them across the Arctic, but far apart if you have to avoid the Arctic and go round-about, east or west through the temperate zone.

We in the "civilized" countries fear the Arctic which we do not know, and treat contemptuously the Atlantic and the rest of the southerly oceans, for we know them. But do we really know them to be anything except merciless, especially in a storm? On what sea but the Arctic could you make two safe landings, repair your machinery, take off again twice, fly till your fuel is gone, and then land, go to bed, and sleep the night dry and comfortable 100 miles from the nearest land? And on what other sea could you spend five days preparing a travelling outfit, as Wilkins and Eielson did, and then walk ten days, as they did, to a safe landing at a calculated spot? On no other sea, except possibly the Antarctic, and there the success of so long a walk to land would be unlikely because of the strong offshore winds.

On 30 May 1927 Wilkins flew out over the polar sea again. They flew north-east from Barrow, intending to cross by the longest diameter the unexplored section to North Greenland. But after flying 400 miles,

the last 300 of them in the thickest fog, they turned back, considering it likely (as indeed all agree it was at that too late season of the year) that they might fly the whole distance permitted by their fuel without seeing anything. They aimed for and landed safely at the Oliktok trading station, about 100 miles east of Barrow, thus showing both the rightness of their technical navigation and the feasibility of landing with a fairly heavy load on the natural landing places of the Arctic coast. They made a depôt there of most of their fuel and supplies (for Wilkins hopes to carry on next year), and then flew first to Barrow and next the 600 miles across prairie, mountains, and forest to Fairbanks, Alaska, 100 miles within the temperate zone, all without incident.

Thus ended the Arctic flying of 1927, and we are in a position to sum up the results of the last three years, from the point of view of the future of transarctic commerce by air. The navigation has been, on the average, as exact as the average navigation of the flyers that have crossed the Atlantic. This confirms the theoretical prognosis that, while some of the navigation problems of the Arctic are different from those of the Atlantic, they are not insoluble, nor so difficult as to be an important hindrance to development. Flying boats are less suitable for the Arctic winter than land planes equipped with wheels or skids; for open water on the high seas of winter is abundant only during and soon after ice movements caused by local or distant winds, and landing places on the ice for skids or wheels are numerous far from land, though rare within the 50-mile belt nearest a coast that is subject to strong winds from the sea.

The air conditions found by the flyers were those expected by students, conforming to the weather observations taken by explorers during the past several centuries.

For both airships and airplanes, the best flying season over the Arctic is that of cold weather with clear skies and rare winds—November to early May. The worst seasons are the transition periods of spring and autumn—late May to late June and late August to October. Midsummer should be intermediate, not so good as winter but better than either spring or autumn. Taking the average for the whole year, fogs are fewer, fogs are lower and easier to fly over, precipitation is less, winds are milder and fewer over the Arctic than over the North Atlantic. For at least half the year the superiority of the Arctic in these respects is marked.

Fundamental in the near future will be the publication of weather maps for the whole world daily, if not hourly. Navigators of aircraft have a freedom in the choice of routes not possessed by travellers by land or sea. On the basis of winds, clouds, and every other condition, they will choose a fresh route for every long voyage. Between cities in Northern Eurasia and in Northern America (as, for instance, Winnipeg, Calgary, Edmonton in Canada, and St. Petersburg, Ekaterinburg, Tomsk in the U.S.S.R.) the preferred route will usually lie somewhere across the Arctic, and frequently nearly through the middle of it. Between certain cities, such as

London and Vancouver, the shortest route will be along the edge of the Arctic; but navigators going between them will frequently prefer a slightly longer route nearer the centre of the Arctic because of the better flying conditions—lighter winds, clearer skies, greater cold, etc.

It has not generally been much considered what a great advantage increased cold is in flying. It will have some advantages even for airplanes, but we shall consider chiefly the airship gains, remembering that, *mutatis mutandis*, and in varying degrees, the airplane is affected also. The first advantage of low temperature is that frozen precipitation is dry. A tropical rain or a wet fog will dampen the envelope and increase dangerously the weight of an airship. There will doubtless be invented better and better methods for dealing with this added weight, but in the past it has frequently threatened to bring the craft to earth, necessitating the reluctant discharge of ballast and even cargo. Sleet and damp snow are worse. Sometimes these, and even rain, fall in freezing weather; they stick as snow and may cling even more tenaciously as ice. Byrd reported freezing rain and ice forming on his plane over the Atlantic on the last day of June (1927) when flying from Newfoundland towards Ireland. Accordingly you would meet that danger on the shortest, or great circle, route from New York to London during eight months out of every twelve. In winter you might meet it even on the direct flying route from Florida to Spain. In spring, summer, and autumn you might meet it along most of the usual flying route from Moscow to Vancouver, which will probably be via Finland, the north tip of Greenland, and across Victoria Island. But in midwinter you would not meet on that route sleet, damp snow, or anything that would cling to and weigh down your craft, unless it were just after leaving London or just before arriving at Vancouver, and therefore over or near a settled country. But of this sort of weather you would have fore-knowledge through the reports of the weather bureaus of the countries traversed; and you could choose another route, or anchor at some mooring mast and wait for better weather.

The only exception to the dryness of the transarctic route in winter is that on the average once or twice a season you may have thawing midwinter weather and damp precipitation even near the centre of the Arctic. But this would certainly be foretold by the weather bureaus in ample time to change the course or delay the voyage. Apart from this, the northern winter precipitation is light as eider down and dry as desert sand. If such snow falls on the envelope of an airship going at even 10 miles an hour it will all be blown away instantly by the breeze created by that speed. Only with engines broken down and the ship drifting before the wind could such snow be a source of danger.

As stated above, clouds are few and snowfall of any sort rare in the Arctic winter. But they are not rare near either Moscow or Vancouver, and winds are both more frequent and more violent in many parts of the temperate zone than in most parts of the Arctic. The greatest dangers

and difficulties will therefore have to be met near your home or near your destination. Those who have flown on Zeppelins in winter have already faced, or avoided through weather forecasts, as bad dangers from precipitation or wind as if they flew in January from Berlin to Fairbanks, Alaska, by way of the north tip of Greenland. True enough, there might be considerable difficulty with fogs and damp snow when you proceed south just before reaching Prince Rupert or Seattle, for the coasts of British Columbia and the State of Washington are notorious for thick weather. But the interiors of these countries are dry, with clear skies, and you could avoid bad weather by coming south on the east side of the mountains, then turning a right angle and approaching your destination from the east. With its complete freedom of route, and with a speed that is greater than that of most storms, the airship can nearly always choose its own weather, or avoid it.

The second advantage of low temperatures is that cold air is heavier than warm, giving the airship a greater lifting power.

Other things being equal, a freighting airship would therefore always choose the colder of two available routes. Passenger ships would usually do the same, for the passenger quarters would be kept warm by radiators carrying the exhaust heat from the engines—a problem no more serious than that of heating railway trains in cold weather. Before the railroads were built across the Canadian prairies, it was urged against them that trains could not operate at 50° F. below zero ; but experience has shown that the Canadian trains, even on the rare occasions when the temperature falls that low, maintain their schedules as well as trains on more southerly railways and keep their passengers just as comfortable, viewing the scenery just as pleasantly through windows that are never even clouded by frost. The transarctic airship will seldom meet weather colder than do the Canadian passenger trains. Whenever the airship does it will welcome the opportunity, for it can keep the passengers as comfortable and it will be able to carry more of them.

A third advantage of low temperatures, or at least of an arctic climate, is that whatever dangers there are from lightning, such as possible explosions of hydrogen, will be eliminated within the polar regions at certain times of year and minimized at others.

A fourth advantage of low temperatures, and one easily deducible from current theories, was reported by Wilkins in very decisive terms. He said that in flying five times north from Fairbanks to Point Barrow and four times south from Barrow to Fairbanks, part of the time over such mountains as would be sure to be full of " air pockets " or " air bumps " on a hot day, he never noticed one bump or pocket on those flights that were done in cold weather—always below freezing and sometimes thirty or forty degrees below zero (F.). This was on a total flying distance of about 5000 miles. But on his fifth southward flight, when the spring sun had removed the snow from much of the land (towards the end of May),

he encountered as many pockets and found the air in general as rough as over similar topography in the temperate zone. This refers to the flights of 1926; the corresponding report for 1927 has not yet been published.

The weather conditions that destroyed the American airship *Shenandoah* could be found in the Arctic only in summer, which is a much shorter season there than in Ohio, where the *Shenandoah* was wrecked —only from three-quarters as long at, say, Great Bear Lake, to one-fifth as long at places like Meighen Island.

Other advantages that go with low temperatures, as already stated or implied, are gentler winds, fewer fogs, fewer clouds, increased range of visibility, simplified navigation problems (because of sun or stars being more constantly visible), and lessened snowfall.

There are of course obvious disadvantages of cold. They cancel some, but not all, of the advantages. The balance remains in favour of the Arctic routes as compared with the North Atlantic. The same would appear if they were compared with the North Pacific, as, for instance, the direct or great circle route from either San Francisco or Vancouver to Japan.

The situation, then, as to the prospects of transarctic commerce by air remains the same in the main after three years of arctic flying in 1927 as it was three years before any arctic flying was done. Then we had only scientific deductions to go on, but they were bound to be right, for they were based on verified data gathered through centuries. Or if there is any change in opinion it is chiefly that, thanks to the work of Wilkins and Eielson, we have greater confidence now in the landing powers on the deep-sea pack of planes equipped with skids. But in spite of that greater confidence we must believe the airship is superior to the airplane for the Arctic. It is probably superior for all the oceans now, and will long so remain. But the North should be its chief field; for there it has unparalleled opportunities and advantages for lessening danger, saving time and money, thus bringing into closer touch cities remote by temperate-zone routes but which are near each other across the Arctic.

RECENT SHEETS OF THE ONE-IN-A-MILLION MAP OF THE AMERICAN GEOGRAPHICAL SOCIETY

Col. H. S. L. WINTERBOTHAM
C.M.G., D.S.O.

AMERICA is full of surprises in the matter of her contribution to the 1/M map. Immediately after the war, both North and South America must have reported large areas as begun for the 1921 report, and the international index showed no less than 40 sheets for North America and 45 for South as in hand. Then for some years we heard of little progress, until Brazil, on the anniversary of her declaration of independence, presented us with a complete block of 48 sheets. In 1925, however, we had had the La Paz sheet (S. E 19) issued by the American Geographical Society, and we were, at the same time, informed that a block of nine more was in hand. Those nine have now appeared, and South America, less well known geographically than any other continent, definitely takes pride of place in the area covered by 1/M sheets.

The policy of the American Geographical Society, referred to here and there in the journal of that body, is outlined by Alan Ogilvie in 'The Geography of the Central Andes,' published in 1922. The ultimate aim is no less than to map, at this scale, all that part of the Americas lying south of the Rio Grande del Norte. The first reflection natural on grasping this idea is that the international aspect of this map gives to each country the right to map itself if, in the words of Section 14 (*a*) of the Paris resolutions, it "possesses a suitable cartographic establishment." Five of the sheets now produced cover the Windward and Leeward Islands respectively. We may, as an Empire, be supposed to possess several "suitable cartographic establishments," but I am confident that we all agree in thanking the American Geographical Society for these particular sheets and in hoping that they will carry on the good work by producing those covering the Bahamas, Jamaica, and Trinidad. At the same time this underlying idea of national responsibility probably explains the fact that no mention of an international character is made on the left-hand top corner of any of the sheets, in spite of the fact that the Paris resolutions have been followed more literally than is usually done.

Maps of South America are as diverse, numerous, and conflicting as maps of an unsurveyed country can well be. There are few topographical surveys in existence, and very little mapping with any claim to accuracy. The material available is mainly that collected by boundary commissions, explorers, and engineers; and takes the form of thin lines of varying reliability. To say so much is not to criticize adversely the 1/M maps of Brazil. Indeed, the labour in compiling the 48 sheets of that great undertaking must have been colossal. The result cannot however be very reliable.

The first ten sheets of the Geographical Society's programme to

appear are N. G 10 (Lower California, unlayered and in special sheet lines), N. E 19, N. E 20 and N. D 20 (West Indies), N. A 17 (coast of Columbia and Ecuador with the Galapagos Islands as an inset) and S. C, D, E, F and G 19 (mainly of the Chilian and Peruvian highlands). The first sheet N. G 10 will not be further mentioned. It is a useful sheet, but, as far as reproduction goes, in the nature of a trial trip.

Sound principles of compilation have been observed. As far as possible every original contribution has been given due weight, but, on the other hand, drastic changes have been made where evidence seems to warrant it. Thus in the La Paz sheet Cochabamba is moved by 13 minutes of longitude (or roughly as many miles) from its formerly supposed place. It is not only in topography but in place-names too that knowledge seems to be scanty. In general terms, then, we cannot place implicit reliance on either position or name, but we can say that the Geographical Society has given us the best that patient and well-directed compilation can do.

There is much to learn in the compilation of contours, and it is interesting to compare styles in the various 1/M sheets with regard to this particular point. Now in sheet N. E 19 there are well-surveyed and comparatively unsurveyed areas side by side, and so clear is the difference of contouring that there is no need to look at the margin for the diagram of reliability. Should we, or should we not, give really intricate contouring at this scale? To do so is so tempting that I confess to "falling for it" every time. Yet I doubt if much good results, and a map containing both well and badly surveyed areas may become very patchy to look at. A contouring which follows every minute curve has the drawback of carrying too much colour and of claiming in consequence too much prominence. The G.S.G.S. 1/4 M map of South Russia is a case in point, for the Caucasus mountains are given in far too much detail.

Two of the sheets, for very good reasons, extend the normal sheet area (6 degrees longitude by 4 of latitude). In the interests of a homogeneous series a more or less strict adherence to the prescribed sheet lines is desirable. It cannot always be given, however. Convenience and economy sometimes combine to make a departure almost unavoidable, and after all sheet lines are made for the map, not the map for sheet lines.

In the earliest sheet (La Paz) names are typed and are no pleasanter than typed names generally are. I fancy that the failure of typing is mainly due to a tendency to narrow spacing and cramped effect. Curiously enough, this same criticism applies to subsequent sheets in which the names are often (if not always) written. These written names are sharp and neat, but somehow lack distinction. It would pay better to reduce the height of letters in "busy" areas rather than to narrow both letter and spacing, and in open areas to give a more rounded letter with more room between them. For all that the later sheets show a

marked improvement in writing, even if there is still some way to go before reaching the standard of (say) N. O 33 Norrköping.

One minor point to criticize in the international convention is the lack of difference between 5th and 6th class towns. The American Geographical Society have, apparently, come on this difficulty and have adopted a fine upright Egyptian case for the 6th class, making the distinction clearer.

The drawing is good throughout. Rivers are well graduated and symbols finely and regularly drawn. Conventional signs seem to follow very closely the international model. One notices that the national ownership of cables is not given, that irrigation canals are in black line instead of the blue symbol provided, and that sandbanks are also in black instead of blue. The very fact of international agreement means however that some of the symbols must be strange in every case, and on the whole, as I have said above, there is a very close adherence to the resolutions.

Whilst on the subject of symbol it will be as well to refer to the " Salar " of Chile or " Salina " of the Argentine. They are very large areas described as " salt encrustations," and must be a dreary item on the landscape. They are shown by a fine black stipple over a blue ruling, and make a gap in the layer system so like water that it takes some time to grasp how it is that railways and roads are shown crossing them. No doubt these salt encrustations must be shown, but should they be so like water, and should they interrupt the layer scheme ? I do not think they should unless they are flooded at times, but all the same I have no constructive idea to advance. To my mind the worst symbol agreed upon at Paris is that for international boundaries. The heavy crosses of this symbol are particularly difficult to make into a sinuous line, and that fact is brought out prominently in the sheets along the Chile, Peru, Bolivia, Brazil, and Argentine boundaries.

Contours follow the proper intervals, and auxiliary contours are inserted where space permits. Full advantage has been taken of the difference between " surveyed " and " unsurveyed " symbols, but line or broken line is employed instead of the fine dots.

Marginal information is carefully and correctly given. For example, none but those symbols actually employed on each particular sheet appear in the marginal list. Native terms, the system of transliteration, and the pronunciation of Spanish and Portuguese names are given in a helpful way. Probably Indian names are the main difficulty, as they must come through the medium of Spanish, and no doubt lose much in the process.

Reproduction is stated to be photo-lithographic. Probably originals were drawn for reduction and reproduced by heliozincography. The drawing does not seem to have lost fineness in this reproduction. Printing was, I think, on a " flatbed."

These nine sheets provide much scope for comment on the international layer system, for they range from the top of the Andes to ocean depths. The impression left on one's mind is good if one remembers what a stupendous task is set by so wide a range. All the same there is something to criticize in the actual technique. To start with water, the layer tints are not very well graded in tone. The shallowest water is too light, appearing almost white. That seems to be due to a ruling of about 76 to the inch, which is too open for the purpose. Each blue printing has a ruling, a cross, and a solid, and is carried on (the solid) under the next printings. The effect varies from sheet to sheet according to skill in transferring, and I am bound to say gives, here and there, a switch-back feeling rather than that of a uniform slope. On land the green gives much the same effect, for the solid is too dark and the ruling between it and the solid first buff is too open. A ruling next a solid is better in cross than in single line. The buffs do not give a very satisfactory gradient either. That seems to be due to the fact of alternating the type of overlap between printings. Thus a solid second buff is printed over a cross-ruled first buff, and the same occurs between fourth and third buff printings, whilst the cross rule of the third is printed over a solid of the second buff. This very technical digression may seem overlong, and yet the easy and natural gradation of layer is both one of the most pleasing and one of the most difficult factors to secure. The most difficult thing in the international 1/M style is to get correct the colour value of the rulings which underlie the solids.

It is however always easy to criticize, and the geographer will wonder at the length to which it has been carried; for the 1/M of South America will be a very great boon. Good luck to the enterprise, then, and may all the sheets be as good as those we have reviewed.

COLONEL FAWCETT'S EXPEDITION IN MATTO GROSSO

THE last authentic news of Col. Fawcett is dated 30 May 1925. He warned his friends before starting that they must not be surprised if they did not hear from him for two years or more, and they all like to hope that his long absence should be interpreted as indication that he has succeeded in his quest, rather than that he has failed. There must however by this time be anxiety for his condition if not for his fate. Such anxiety was expressed by our late President in his Anniversary Address on June 20, and the public interest aroused by this reference has led to strange incidents that should not go unremarked. The time has come when it is desirable to put on record what we know of Col. Fawcett's plans and objects; what is contained in his last reports; and what must be thought of certain fantastic stories that have been put about in the last few months.

As soon as he was released from the military duty to which he had returned on the outbreak of war in 1914, Col. Fawcett reverted to a project he had long studied. His previous extensive journeys in the basin of the Amazon had led him to believe that results of great interest and importance both to geography and to archæology might be obtained in the hardly penetrated regions between the upper water of the Tapajos, Xingu, Araguaya and Tocantins. From a first attempt in 1920 he was compelled to return by the breakdown of his companions—a thing not unusual in those who have tried exploring with Col. Fawcett, who was prepared to travel lighter and fare harder than most people would consider either possible or proper. He returned to England and busied himself with preparing a new attempt.

Early in 1924 he submitted to the Council of this Society a plan for the new expedition. He proposed to leave civilization at Cuyabá and strike north with mules to the Paranatinga, descending that river by canoe to about latitude 10° south, and then striking eastwards on foot, cross to the Xingu, thence to the Araguaya, make for Port Imperial on the Tocantins, and come out at Barra do Rio Grande on the São Francisco. He considered that no expedition could carry food for more than three weeks, for animal transport is impossible owing to lack of pasture and to blood-sucking bats; and no supplies could be obtained for a party including carriers. He intended therefore to carry a few indispensable articles and instruments in packs, and to live on the forest.

In May 1924 the Expedition Committee, having carefully considered a detailed memorandum submitted in explanation of the plan, and heard further particulars from Col. Fawcett in person, reported to the Council that in their opinion the proposed expedition was very desirable from a geographical point of view; and the Council thereupon decided that it was their duty to give the plan their approval and moral support. They

regretted that the funds of the Society did not permit them to offer any substantial help, but undertook to provide and if necessary have specially constructed certain exceptionally light survey instruments which could be lent for use upon the expedition. In the end the Society bought for Col. Fawcett about £100 worth of new instruments, including a 4-inch theodolite, a 3-inch sextant, aneroids, compasses, etc., and lent him two half-chronometer watches engraved R.G.S. Nos. 16 and 24. To this small extent the Society assisted financially. It is understood that Col. Fawcett obtained some part of his funds by contracting to send reports from time to time and give the final story to a news organization in the United States, with which a London newspaper is associated.

Col. Fawcett, with his elder son Jack, reached New York on 10 December 1924, and was joined there by the third member of the expedition, Mr. Raleigh Rimell, a young Englishman, son of a naval surgeon, who had been living in California, and has therefore been wrongly supposed an American. They travelled *via* Rio de Janeiro to the Paraguay, and thence to Cuyabá, from which Col. Fawcett wrote to the Secretary on March 7 :

> "We are here at stepping-off point, collecting animals for a start into the forests at the beginning of April, when the dry season may be said to commence. There has been unusually little rain this year, which is to the good, and everything seems to point to making a most advantageous inception of the expedition. Thanks to the good will of the British Foreign Office, who instructed the British Ambassador in Rio, and to the unbounded courtesy and sympathy of the Ministers of the Federal Government, our ways have been remarkably smooth. . . . Such general goodwill of officials, Federal and State, for the same applies to Matto Grosso, makes it a pleasure to do the State and Brazil a good service, apart from the scientific aspect of the exploration. The Government very kindly took the view that Brazil was under the obligation to do all that it possibly could. The moment in fact is singularly propitious. . . . All our equipment is here undamaged, and instruments are in good order. I do not think it is at all probable we can get any information back from in or beyond the region of these primitive people [the people who, the writer explains, have the unpleasant habit of carrying their victims threaded on a bamboo or slung to it by the tendons of arms and feet, feeding on them in a state of decomposition], but I shall attempt to get it out through the agency of Indians, if I can. Two men will accompany me to help with the mules as far as I got in 1920, or possibly beyond, that is round about 12° south latitude. I know they will not face bad Indians, and it is indeed rather a risk to take them in. We three shall therefore manage the troop ourselves, reducing it if necessary, beyond that point. The party are all fit and well, and consists as you know of my son, and Mr. R. Rimell. They are strong and capable of great endurance. We reach higher country after about six weeks to two months. Complete ignorance regarding these enormous areas has left the fact of high country unknown. We shall welcome it as a respite to virulent insect attacks. . . . Science will I hope be greatly benefited, geography can scarcely fail to gain a good deal, and I am confident that we shall find the key to much lost history."

The last letter received by the Secretary from Col. Fawcett is dated 20 May 1925 from Bakairi Post, Matto Grosso, latitude 14° 15′ 44″ south, longitude 54° 32′ 30″ west of Greenwich, altitude 451 metres, variation 5° 17′ west (1925). It was received in London on August 4, and begins

> "Just a line from this outpost of civilization to advise you that we are about to go out of communication. We are all three well and fit, and there is every hope of a successful issue to the expedition, risky as it is in some ways."

A long letter from Mr. Jack Fawcett to his mother, dated Bakairi Post, Matto Grosso, 16 May 1925, gives many particulars of the journey. They had arrived at the post on May 15, having left Cuyabá on April 20 with about a dozen animals: horses fairly good, the mules weak. Rimell, who had been suffering from a poisoned foot, was nearly well again, and they were to start north from Bakairi Post on May 21. The last letter from Col. Fawcett to Mrs. Fawcett is dated 29 May 1925, and begins

> "Here we are at Dead Horse camp, latitude 11° 43′ south and longitude 54° 35′ west, the spot where my horse died in 1920. Only his white bones remain. My calculations anticipate contact with the Indians in about a week or 10 days, when we should be able to reach the waterfall so much talked about."

From this camp, renamed "Camp Fawcett," Matto Grosso, Col. Fawcett sent on the following day, May 30, the last dispatch received by the North American Newspaper Alliance, which reached Rio de Janeiro in November, and was published in *The Daily News*, 3 December 1925. It contained relatively little further information:

> "From Fort Bakairi, whence I sent my previous dispatches, our journey has been no bed of roses. We have cut our way through miles of *cerraba*, a forest of low dry scrub; we have crossed innumerable small streams by swimming and fording; we have climbed rocky hills of forbidding aspect; we have been eaten by bugs. . . . Our two guides go back from here. They are more and more nervous as we push further into the Indian country. All our animals survive. Seven or eight will go on with us, the rest go back to Cuyabá with the guides. We shall not get into interesting country for another two weeks. I shall continue to prepare despatches from time to time, in hopes of being able to get them out eventually through some friendly tribe of Indians. But I doubt if this will be possible."

From the position given for this camp, which is about midway between the rivers Paranatinga and Xingu and not so far from the latitude at which Fawcett proposed to strike east, it seems possible that he had abandoned his intention of going down the Paranatinga by canoe, and was keeping to the higher intervening country. From this date 30 May 1925 there is no news of the expedition to which any credence can be given.

Rather more than two years from that day Dr. Hogarth in his Anniversary Address to the Society said:

> "We hold ourselves in readiness to help any competent and well-accredited volunteer party which may propose to proceed on a reasonable

> plan to the interior of Brazil in order to try for news of Colonel P. H. Fawcett, of whose long silent absence (now yet longer by twelve months) I spoke at the Dinner last year. I am forecasting a mission of inquiry alone, not one of relief. The latter is out of the question in the circumstances, as Colonel Fawcett himself stated emphatically, when he proposed to go where none but he could hope to penetrate and pass."

This statement attracted much attention in the newspapers, and was soon interpreted as meaning that the Society was prepared to organize and finance an expedition. Offers to take part flowed in from all over the world from men who were prepared to go in any capacity, from that of leader of the expedition to that of "chef." The majority of these applicants had clearly no idea whatever of the conditions. A few offers deserved and received more serious consideration, and the above facts were placed at their disposal. For one reason and another their plans failed to mature, and only two projects survive. A Fellow of the Society, Mr. C. F. C. Luxmore, sailed some months ago for the Amazon, hoping to be able to make a journey up the Xingu or the Araguaya and perhaps to obtain some news of the missing party. To the expedition of Commander Dyott we shall refer later.

Meanwhile there had been reports in various newspapers that a Mr. A. H. Morris had returned from an unsuccessful expedition in search of Col. Fawcett. In the previous May we had been informed officially that this gentleman had stated that when travelling in the interior of Brazil on a scientific expedition he was attacked by bandits and robbed of all his possessions, including three thousand pounds. He had stated further that he was a Fellow of our Society, and that it was on business connected with the Society's work that he was travelling in Brazil. A search through the registers back to 1897 showed that no one of that name and initials had been a Fellow of the Society during the last thirty years, and in May we had replied to an inquiry, that nothing was known of him at all except from recurrent paragraphs in the newspapers, which stated that he had met with misfortune on an expedition organized by the Society for the relief of Col. Fawcett, that he had returned to refit, and was going out again under our auspices. On July 5, however, we received this cablegram: "Willing to seek Fawcett again. Telegraph funds British Consul Porto Alegre. Morris." To this request no reply was returned.

On 11 July 1927 Dr. Hogarth addressed to His Excellency the Minister of Communications of the Brazilian Government, through His Majesty's Ambassador at Rio, an inquiry whether any news or rumours of Col. Fawcett's progress or fate had reached the Ministry or any Department of the Brazilian Government, and whether the Minister had at his disposal the means of obtaining any such information from the posts in Matto Grosso under his orders; or if that were not possible, whether he could give advice on any other means of securing such information.

A few days before the Secretary had, on a suggestion made to him by a Fellow of the Society, addressed a letter to the Reverend Monseigneur Couturon, the head of the Residencia Salesiana, and Administrator Apostolic of the district of Matto Grosso, asking if he would be so good as to cause inquiries to be made by members of his Mission for news of Col. Fawcett and his companions, since it seemed possible that if the party had met with any disaster there would be some chance of learning what had happened by inquiry among the Indian tribes with whom the Mission were in constant communication.

While we were awaiting replies to these inquiries there came a report which has greatly obscured the situation and led to curious developments.

On 10 September 1927 *The Daily News* published a report that a Mr. Courteville had met Col. Fawcett and his two companions about 100 miles from Diamantino; that the three explorers were fascinated by the beauties of tropical nature, that Col. Fawcett is now a man without any desire for the bustle of civilization, that his expedition in search of the fabled lost city failed in 1925, and that, his son falling seriously ill while they were still in the dense forests, he decided to settle down as a farmer. Some days later this improbable narrative was amplified as follows: Mr. Courteville (or Conteville), of French nationality, had been engaged on a journey by motor from Rio de Janeiro viâ La Paz to Lima, and on arrival in Lima in September had related that on the Cuyabá road he had found, near a buried city, a man between forty and fifty sitting on the ground wearing shorts and a khaki shirt and apparently suffering from fever. After a few trivial words in English on the subject of mosquitoes Mr. Courteville had gone on his way, and had been told at Cuyabá that this must have been the British explorer, Col. Fawcett, who had gone up the river Xingu with his son and another they said was an American named Raleigh Rimell, that Col. Fawcett's son had been ill with malaria, and that he had returned. Several people had said that Col. Fawcett was living between Cuyabá and Diamantino, doing nothing in particular.

Embroidered with fantastic details this story was widely circulated, and the North American Newspaper Alliance got into touch with Mr. Brian Fawcett, the Colonel's second son, who was in Lima and interviewed Mr. Courteville, being apparently persuaded that the man referred to might have been his father. There was much talk of Mr. Courteville's intention to return on a relief expedition, and the Society received through two cable companies the statement that Mr. Courteville, "Chief of the Fawcett Rescue Party," had asked them to accept telegrams from him without payment addressed to the Society, the cost of the same to be collected on this side. To this we replied that the Society knew nothing about Mr. Courteville except what had appeared recently in the papers, that we had had no communication from him, had no intention of asking him to take part in any search for Col. Fawcett, nor had we any reason

to believe that he had any right to describe himself as "Chief of the Fawcett Rescue Party."

On October 3 we received from the Foreign Office the following telegram addressed to them by H.B.M. Ambassador at Rio de Janeiro:

> "Inquiries have been made by the Brazilian Government in the interior, but they failed to trace Colonel Fawcett or any other of his party, and it is feared that they have perished. . . . Letter follows";

and on October 19 the President received the letter from the British Embassy at Rio, forwarding the following translation of a telegram addressed by the President of the State of Matto Grosso to H.E. The Minister for Foreign Affairs of Brazil:

> "I have the honour to confirm my despatch of the 27th August, and to acknowledge the receipt of Your Excellency's despatch of the 12th instant, in reply to which I beg to inform you that, after all the attempts made by my Government to trace the whereabouts of Colonel Fawcett, the only information obtained is as follows:
>
> "Colonel Fawcett and his two companions left this Capital (*i.e.* Cuyabá) in a north-easterly direction reaching the margin of the river Xingu, where they sent back the party of Mafuquas Indians, who had accompanied them. Continuing their journey and not reaching Latitude 11°, they branched off to the east, in the direction of the Araguaya River, whence no news at all has been received of them. It is believed that they have been killed by one of the various tribes which inhabit the banks of the river Xingu, as a farmer living at Paranatinga states that one of the dogs which were taken by the expedition returned alone to his farm some twelve months ago.
>
> "The notices sent to the Press of this Capital by the French military ex-sergeant, Courteville, are totally unfounded, as that tourist followed a route very far from the region where Colonel Fawcett was pursuing his expedition. Courteville journeyed in a straight line from the city of Tres Lagoas to Cuyabá, travelling on excellent roadways near the Garimpeiras zones which are well populated, whilst Fawcett, as stated above, went to the North-Easterly region, into the heart of the country, via the city of Diamantina."

On 10 December 1927 we received from Monseigneur Couturon a letter dated "Registro do Araguaya 30.10.27," saying that in spite of inquiries which had been made he was unable to give any news of Col. Fawcett or his companions.

Meanwhile Monsieur Conteville (as he is now called) had returned to Rio de Janeiro, and the newspapers were filled with a slightly different version of the alleged encounter with Col. Fawcett, based upon a diary of the tour said to have been written in Lima some nine months after the encounter. Through the courtesy of the British Ambassador and the Foreign Office we have received an abbreviated translation of an article published in the Rio paper *O Jornal* of 22 November 1927, with the following extracts from the diary:

> "... We were passing by Chapada in the direction of Burity, when we saw a man, on the right of the road, apparently exhausted with his hands on his knees. ... He was a man of from 50 to 60 years old with luxuriant greyish hair and a 'pepper-and-salt' beard. ... He was wearing khaki shorts and trousers, such as those worn by scouts, with a wide-brimmed hat. ... As I approached the man continued to stare at his feet. To start conversation, I asked him if we were far from Cuyabá, but he did not seem to hear. His bare and hairy legs, on which a colony of mosquitos and insects had settled, were shod with enormous shoes that must have been very old. His heroic stoicism was so odd that I thought he must be a foreigner and addressed him at random in English—'I say, man, the mosquitos seem to take care of you' [*sic*]. My remark produced its effect and he looked up at me. His face showed obvious signs of fatigue and general weakness consequent on fever, but his eyes were straight and forceful, and I had the impression that this man had been a soldier. ... Finally he replied, 'Those poor animals are hungry too.' We went on our way leaving the poor man calmly watching the mosquitos devouring his legs."

From this point the narrative varies from the original. It was an unnamed friend with whom he had been shooting crocodiles who told M. Conteville that it must have been Col. Fawcett. After giving the same account of the journey as far as Dead Horse Camp, which agrees in the main with what we know, this gentleman added that the party had succeeded in reaching the Xingu, "but young Fawcett suffered from malaria. There they settled on the 9th parallel [*sic*] according to statements made by Indians in that region."

Upon this slight and improbable story, which amounts to no more than that in September 1927 M. Conteville remembered having met somewhere near Cuyabá a man who spoke English that might have been Col. Fawcett, the Brazilian paper comments thus:

> "... The international scandal provoked by the discovery of the explorer Fawcett who is living in the interior of our country as a rancher, has turned the attention of the world on the Brazilian hinterland. ... The English Colonel had received large sums from his Government and from scientific societies in Great Britain. His new role of 'Gentleman-farmer' in Matto Grosso in place of that of a defenceless victim of Brazilian Indians sheds a strange light on the case. ... Events occurring since the unexpected discovery made by Roger Conteville have made the case even more mysterious and even, perhaps, frankly unfavourable to the English explorer. ... In Lima Mr. Conteville met the son of Colonel Fawcett, who living in the civilized Peruvian metropolis could not quiet his mother's anxiety by revealing his safety. The death of Colonel Fawcett and his son has been officially recognized by the British Government, who are paying a pension to his widow. Those persons who announced his death are now organizing costly expeditions to prove the truth of their assertion. The 'Fawcett Case' must therefore be fully cleared up, so that we may know whether to lament a death in the cause of science or to punish an imposture." (*Translation.*)

In view of these allegations the Secretary of the British Embassy called

upon Monsieur Conteville, who repudiated the greater part o the statements attributed to him, describing them as inventions on the part of the reporters, and emphatically declaring that he had said nothing about the pension. It is indeed sufficiently clear that the "international scandal" is an invention of the newspaper; but M. Conteville cannot escape responsibility for having originated the story.

A correspondent in Rio has very kindly sent us a complete translation of the article in *O Jornal*, which contains, with much rubbish, a few more geographical details than were given in the précis from the Embassy. The Chapada referred to is near one of the affluents of the Rio Casca, and the distance to Cuyabá measured by speedometer from the place of meeting to Cuyabá was 162 km. At some river crossing a little earlier an Indian had told by signs that two white men had come there from the direction of Cuyabá and had drunk from the river.

A long cable from Lima dated October 22, published about a month before in the *New York Times*, gives much the same story of the Indians, except that their indication was that the white men had come from the north. But the unnamed crocodile hunter, who now figures as a "friend in a Government position," adds a story that we have not found elsewhere:

> An Indian called Ouakh of the Parintintins tribe appeared at Parecis, an Indian village, with a mysterious apparatus which was supposed to be the finger of God, always showing the same direction. Ouakh told of two white men, the biggest of whom had a thunder tube for killing. The other white man was sleeping for ever, a five-moon walk northward. He saw a white man making a hole in the earth four days from the burial place, hiding many things which the Indians who secretly followed wanted to see, but the chief of the tribe refused permission from fear of bad spirits. Ouakh said that there were other Indians who had cardboard shells the same as those used in Europe for hunting. These Indians were not attacking the whites, but were not helping them. He said that the whites were staying at a place a fortnight's walk east of the Parintintin village, and had the intention of coming back. One small white man walked badly, supported continually by the other, who seemed stronger, but not so strong as the Parintintins.

The original story of M. Conteville placed the discovery of the Englishman in relation to Diamantino; the later version makes it near Cuyabá. There are several Chapadas and Buritys and Rio Cascas in Brazil, but the 1/Million map published by the Engineering Society shows one of each near Cuyabá that fit the above story, except that the distance by road is nearer 60 km. than the 162 of M. Conteville. He seems to have driven his car along the road that carries the telegraph from Goyaz, but to have diverged a little to the north on approaching Cuyabá, and gone round through Chapada and Burity instead of by the rather more direct route. The place where he saw the alleged Englishman cannot from his indications have been more than about 25 miles from Cuyabá. It is preposterous to suppose that Col. Fawcett could have come back so near

to the town where he was so well known without being recognized: still more that he could have failed to report himself. Nevertheless, the story has been so widely accepted by many newspapers in innocence, and by one in malice, that the above summary of a curious case is not superfluous.

On the grave allegation of fraud it is sufficient to say that of those who believe that Col. Fawcett is still alive, his wife is the most convinced believer. His death has never been assumed. But, on the other hand, since he has not been able to prove himself living, neither he nor his representatives can have been able to receive the military pension due to him for nearly three years. In such circumstances the allegation is especially perverse.

The most hopeful suggestion to account for his long absence, if disaster has not overtaken him, is that he has found the people of whom he went in search, and is making a prolonged stay with them to study the archæological interests he had so much at heart; less hopeful, but not impossible, is the theory that he may be detained a prisoner. A relief expedition, in the ordinary sense of the term, seems to be impossible, for who could define its objective? But a mission of exploration and inquiry to work in the region to which Col. Fawcett went offers at least the chance of learning his fate, and at best the chance of succouring him and his companions. We shall follow, therefore, with high expectation the party organized and led by Commander Dyott which is to leave New York shortly for Cuyabá, intending to work northwards towards the headwaters of the Xingu. Commander Dyott is an Englishman and Fellow of our Society, who has much experience of the difficult art of travel in the Brazilian wilderness. Some years ago he gave us an account of a reconnaissance for an air route which did not lack adventure of the kind that may have befallen the Fawcett party. He has since enlarged his experience by descending the River of Doubt which Theodore Roosevelt explored and described to us. His published intentions of sending daily reports by wireless and making moving pictures of his adventures may suggest that he contemplates an equipment too elaborate to follow in Fawcett's tracks. But he knows the difficulties as well as any man, and we may be sure that he will not allow his accessories to hinder him if he has the good fortune to strike a promising trail.

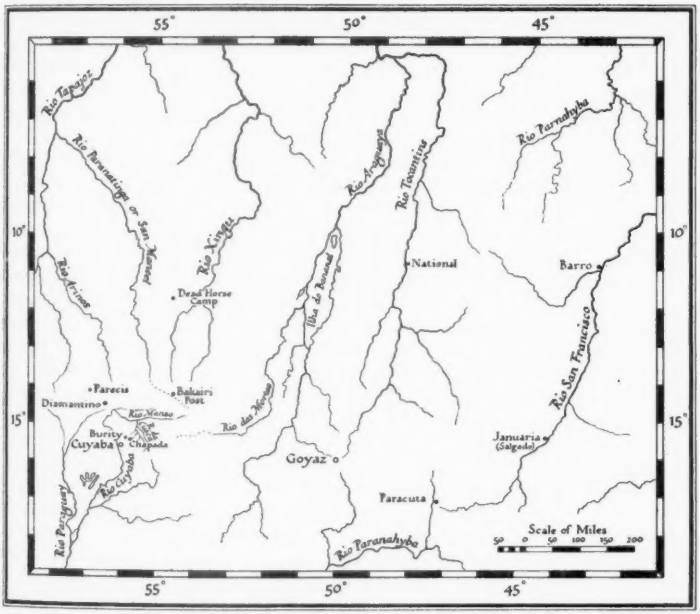
This, then, is the position. We cannot admit a word of the stories that have been put about in the last six months. The last authentic news is nearly three years old. The Brazilian Government and its officials, the British Ambassador and his staff, the Apostolic Administrator and his missionaries, have done all that is possible by advice and inquiry to resolve the problem; and to them all the Society has conveyed its grateful thanks. All the little information in our possession has been transmitted long ago to Commander Dyott, with the Society's best wishes for success in his arduous enterprise.

Note added 19 *January* 1928:

This day we received a visit from Mr. C. N. Collenette, a naturalist just returned from Matto Grosso. On 25 October 1927, at Cuyabá, the Austrian Vice-Consul, Mr. Sergel, introduced to him "one of the last men to see Colonel Fawcett": a farmer from up-country, to whom the dog returned. As he then related the story the dog returned emaciated sixty days after the party had left for the Xingu. From Mr. Sergel he heard also a report that two snake-serum syringes were said to be in the hands of Indians: but on what authority, and how recognized as such, did not appear.

Chapada is a village of thirty houses. Burity is a farm owned by the American Presbyterian Mission, and occupied by a Mr. Martin, who knew Col. Fawcett well, travels much in the district, and entirely disbelieved the Conteville story.

The position of Bakairi Post agrees closely with that marked on Mr. Collenette's map by General Rondon with the name Simoes Lopes, often mentioned in Cuyabá. The Indians on the Paranatinga near that post are restless, and killed a rubber-collector last summer.



Sketch-map of Matto Grosso to illustrate the above account and Colonel Fawcett's intended route

MONUMENTA CARTOGRAPHICA

Monumenta Cartographica: Reproductions of unique and rare maps, plans, and views in the actual size of the originals: accompanied by cartographical monographs. Edited by Dr. F. C. WIEDER. Volume I. *The Hague: Martinus Nijhoff.* 1925. 30×22 *inches; Text* 28 *pages, and* 25 *sheets of reproductions. Ten Guineas*

THERE exists up to the present no authoritative and comprehensive 'History of Geographical Science,' and the need for such a work becomes the more keenly felt by the general student now that from so many quarters facsimiles of rare and hitherto inaccessible early maps are being placed at his disposal: for such maps present many problems. The 'Monumenta Cartographica,' issued in Holland under the editorship of the Librarian of Leyden University, will of course have special reference to the work of the great Dutch cartographers, but it is promised that maps originating elsewhere will not be neglected. The critical and bibliographical notes are written in English, and five volumes are at present planned.

The first and most interesting of the maps in Portfolio I is a world in globe-gores, taken from a collection of ancient maps at Stuttgart. This Dr. Wieder believes to be the hitherto missing 1523 Globe of Johannes Schöner, which the latter prepared to illustrate the epoch-making voyage of Magellan: the track of the explorer is marked on the globe. Since, however, the piece of evidence on which Dr. Wieder relies as finally decisive can be shown to be based on a misreading, the ascription of the Stuttgart globe to Schöner calls for re-examination. The word PERISCII is written across the space between the Antarctic Circle and the South Pole, and is of course the name given to the dwellers in the Frigid Zones as defined by Posidonius, quoted by Strabo.* Dr. Wieder reads it PERISCH, which he interprets as PER J. SCH., *i.e.* By Johannes Schöner: an explanation which must now fall to the ground.

The Schöner Globes are discussed by Harrisse in his 'Discovery of North America,' where he suggests that we have in the Gilt Globe of Paris a copy of the 1523 Schöner, or of a later edition of it. That the Gilt Globe is a copy of the Stuttgart globe seems beyond dispute, for the agreement in outline, place-names and inscriptions is very close. The same globe served as the prototype of the double-heart map of Orontius Finæus, published 1531, and of the known 1533 globe of Schöner, which was accompanied by his *Opusculum geographicum.*

The characteristic and important feature of this group of maps and globes is that they link the whole of America to Asia. At a much earlier date certain cartographers, including Contarini and Ruysch, had adopted the view that the north-east of North America—Terra Corte Real or Baccalaos—was a north-eastern promontory of Asia. If this was accepted, then the discovery that

* This name appears in a very similar position on a much later set of globe gores, published at Lyons by Guilielmus Nicolai Belga in 1603. (Reproduced in 'Remarkable Maps of the 15th, 16th, and 17th centuries.' I. Amsterdam, 1894.) It is also to be found in the border of the heart-shaped world map contained in Hieronymo Girava's 'Cosmographia,' Milan, 1556, and no doubt elsewhere. On the former, it is also placed in the northern hemisphere, though outside the Arctic circle; this points to its having been copied by successive cartographers who did not grasp its significance. The subject of zones, however, was treated in many works describing the use of globes. There are chapters, in which the term 'Periscii' is employed, in the 'Cosmographia' of Apianus and Gemma Frisius, in the 'Tractatus de Globis' of Robert Hues, in the 'Description and Use of the Sphære' of Edward Wright, and in the 'Usages des Globes' of W. Blaeu.

Terra Florida was continuous with Baccalaos, and that in turn Terra Firma was continuous with New Spain and Terra Florida, meant that these lands must be drawn as a great southern pendant to this long north-eastern promontory of Asia. Now apart from La Cosa's inspired guesswork, no map earlier than 1527 shows the American lands as a connected whole : they are displayed, as on Schöner's globe of 1520, as a series of islands. The Spanish discoveries showed that there was no strait through Central America, while the convincing proof that Terra Florida and Baccalaos were united was afforded by the voyage of Verrazzano, who did not bring the news home until July 1524. The inscription *Terra Francesca nuper lustrata* on the Stuttgart and Gilt Globes places them as subsequent to this date. Dr. Wieder meets this difficulty by suggesting that although Schöner wrote the notes to accompany the globe in 1523 he did not publish it until 1524, when he had news of the discovery made for the King of France. This seems unlikely in view of the fact that the globe was a " topical " one, definitely prepared to illustrate the details of Magellan's voyage, which were published in 1523. Further, the Stuttgart and Gilt Globes alike bear the inscription " *De his terris et insulis lege cortesium*," which as Harrisse pointed out is almost certainly a reference to the publication in *Latin* at Nuremberg in 1524 of the letters of Cortes, which in 1522 and 1523 had been published in Spanish at Seville. This again demands a later date for the Stuttgart globe.

A further point of importance is that of Schöner's view of the relation of America to Asia in 1523. In 1520 he speaks of it as a fourth part of the world : in the pamphlet of 1523 he is silent on the point ; but in the *Opusculum Geographicum* of 1533 he declares that on the evidence of Magellan's voyage he considers America part of Asia, accepting Mexico and Central America, as Columbus did, as the lands described by Marco Polo. Now both Harrisse and Dr. Wieder argue that because Schöner had read (in Maximilianus' account) of Magellan's voyage in 1523, he must have formed this conclusion at that date. This is far from being necessarily the case : the inference is not one to be drawn directly from the first circumnavigation of the world, but the current interpretation of the world map which showed Marco Polo's Eastern Asia as an eastern extension of Ptolemy's classical Asia would be seen on mature consideration to be incompatible with the Portuguese discoveries. Hence the great change in Schöner's views, possibly influenced by the prototype of the Stuttgart globe.

It is a further point to note that Harrisse interprets Schöner as stating in his 1523 pamphlet that he had modified his globe as little as was consistent with the new discoveries. Dr. Wieder disputes this translation of a somewhat obscure Latin passage, but it is significant that even in areas totally unaffected by Magellan's work there is no correspondence between the 1520 and the Stuttgart globes. Further, whereas Schöner (1520) has an inscription relating to Columbus and the date 1492, the Stuttgart globe has the inscription " America inventa 1497."

Dr. Wieder himself suggests that, apart from the supposed signature of Schöner, he would have been inclined to think this globe the lost original referred to by Franciscus Monachus. This writer illustrates his *De Situ Orbis* of 1526 by a small woodcut showing America joined to Asia, Cattigara (as on the Stuttgart globe) on the coast of Peru, and a complete land mass covering the Antarctic and adjoining regions. Such an interpretation of the world map must then date from about 1525, but whether it was originally Schöner's remains not proven. It is to be noted that Franciscus Monachus' map differs from the

Stuttgart map in showing the strait across Central America to be found also in the Maggiolo map of 1527. E. G. R. T.

While the supposed Schöner gores form perhaps the item of most general interest in the collection, two of the other maps have a special interest for us in this country, for different reasons. The one (Plate 4) is a somewhat rare map of Central Europe which occurs in some copies of the so-called Lafreri-Atlas with the title 'Nova Germaniæ Descriptio" and date 1553. It was published by Michael Tramezzino, no doubt at Rome like other maps of that enterprising publisher, though the "privilege" was granted by the Venetian Senate as well as by the Pope. The signature NB at the lower left corner has been taken for that of Natalis Bonifacius, though the known maps signed by him in full are from the years 1570–91, and there was another engraver with the same initials, Nicolas Beatrizet, at work round 1553. But no cartographical work of importance can be attributed to the latter, and, as Dr. Wieder says, the NB of this map and of two plans of Rome may refer to an unknown engraver. To Dr. Wieder's list of maps signed by Bonifacius in full should be added the finely engraved 'Scotiæ . . . descriptio' of Bishop Leslie, published at Rome in 1578. of which a copy is preserved in the British Museum inserted in Lord Burleigh's copy of Saxton's Atlas. It appears to have been issued separately and must not be confused with the smaller map in the Bishop's printed account of Scotland. As the British Museum copy is printed on paper made in France, and has attached a brief letterpress description added by the Bishop for French users, with imprint "Rouen, 1586," the map would seem to have been reprinted in France at that date.

The special interest for us in the map of Germany lies in the presence, as in the map of the British Isles printed at Rome in 1546, of the initials G. L. A. accompanied by three flower sprays (lilies ?), which letters are now generally accepted as standing for "Georgius Lilius Anglus"; the attribution being supported by the statement on the British Isles map that it was produced "Anglorum studio et diligentia." As Dr. Wieder writes in ignorance of the original issue of Lily's British Isles (knowing only the later copy of 1556 which does not bear his initials), he does not discuss the interesting problem how Lily came to be associated also with the map of Central Europe, though he recognizes the similarity of style between the latter and the 1556 map, both as regards the lettering, the symbols representing cities, and the outline of the eastern coast of England. It seems not impossible that Lily's signature refers only to the grant of the Papal "privilege," he having been closely associated with Cardinal Pole when living at Rome.

In itself the map is important as a step in the evolution of the map of Central Europe in the mid-sixteenth century, to be studied in association with the productions of the Zells, Gastaldi, and others, lately discussed in *Petermanns Mitteilungen* by Bagrov and Caraci (see *G.J.* 70, p. 408). As this subject lies somewhat off the line of his own special studies, Dr. Wieder makes no attempt to unravel the mutual relations of these maps, merely pointing out that the one reproduced is possibly based on an unknown German prototype, and that it marks a turning-point in the cartography of Central Europe. He gives however useful lists of other known maps having a bearing on the subject in one way or another.*

* In his note on the earliest printed map of Germany, that of Cardinal a Cusa, Dr. Wieder treats this as undoubtedly published at Eichstädt in 1491. Strong reasons

The second map or chart (Plate 5) of special interest to Englishmen is one in MS., drawn on vellum and coloured, which is preserved in the Hague Archives, and which appears to be the earliest to show the results of Cavendish's voyage through Magellan Strait in 1587. Though catalogued as of 1598, Dr. Wieder deciphers the date as certainly 1588. While the main map gives the west coasts of South and Central America after a Spanish model, the blank space in the Pacific Ocean is occupied by a drawing on a larger scale of Magellan Strait together with the east coast of South America from Port Desire southward. The main features, particularly the two narrows marked as "The first Straight" and "the seconde Straight," are clearly shown, and other names bestowed by Cavendish are also given, including C. Joye (for Cape Virgins) and C. Frowarde. It is remarkable that two different charts giving this representation of the straits should have been brought to light for the first time almost simultaneously, for in almost all details that reproduced by Dr. Wieder is identical for this area with that preserved at Florence and lately discussed by Caraci (see *G.J.* 66, p. 383). In the outline of the coasts the two agree exactly, but there is enough difference in the nomenclature to show that one was not copied directly from the other, a few names in each being absent from the other, while the same feature is described as "A Great Gulet" in the one, "A great Indraft" in the other. Whether either map actually accompanied Cavendish on his voyage, as Dr. Wieder suggests, may perhaps be doubtful, as both may have been copied from a lost original. It is quite possible however that the Hague chart was taken to Holland by the pilots who took service in 1598 with the Dutch fleets that sailed for the Straits in that year.

The next map (Plate 6) is the navigation chart originally produced by Cornelis Doetsz (who signs thereon by his initials only) in 1589, but of which the only known version, here reproduced, is the reprint by C. J. Visscher in 1610. It was engraved, like so many maps of the period, by the brothers Joannes and Baptista à Dotecum, and the one copy known is in the National Library at Oslo. This chart is important as one of the earliest steps in the development of the printed nautical charts, in the production of which the Dutch took so prominent a part. It was preceded in this line only by the "Spieghel" of Lucas Jansz Waghenaer (1584–5), and shows some improvement on the chart of the northern waters in that Atlas. That it appeared first in 1589 is known from the list of such works printed by Adriaen Veen in his "Napasser" of 1597. From the general similarity between the works of the four authors mentioned by Veen Dr. Wieder is inclined to argue some sort of association between them, or at least that Doetsz may have worked under Waghenaer's direction. However this may be, the chart in question long remained the standard type for the

were put forward however by Dr. A. Wolkenhauer (*Deuts. Geogr. Blätter*, 26, 1903, 124–8) for thinking that all the four known copies (Dr. Wieder mentions only that in the British Museum) were printed from the same plate, made about 1530, as is to be gathered from Münster's reference to it in a publication of that year. Wolkenhauer also inclined to the opinion that the "1491 . . . perfectum" at the top of the map may have been a misreading for 1451, and have referred to the original completion of the MS. during the Cardinal's lifetime (he died in 1464). Dr. Wieder expresses a doubt whether the Burgkmair, to whom the map is ascribed in the catalogue of the Munich 'Armeebibliothek,' was Thomas or his more famous son Hans. The doubt is set at rest by the inscription at the head of the Munich copy, which states that, after purchasing the original map, Konrad Peutinger entrusted its engraving to his fellow-citizen Johan Burgkmair.

northern navigation, into which new details were incorporated from time to time.

The rest of the plates (7–25) are all reproductions of those in the remarkable Manuscript Atlas of Johannes Vingboons, to the importance of which Dr. Wieder had previously called attention elsewhere (see *G.J.* 65, p. 470). While of the greatest value for the history of the Dutch colonial enterprises in the seventeenth century, it is hardly of equal interest from a more general point of view. It contains both maps and views, of which those given in the first volume of the 'Monumenta' are but an instalment. Dr. Wieder here recounts his persevering researches into the fortunes of the various collections attributable to Vingboons, the most complete of which was at last traced by him in the Vatican, others having either been less extensive or been dispersed in recent times. In some ways the Atlas of Vingboons may be considered an extension of the great work of Blaeu, though the vast scale on which it was planned stood in the way of its publication.

By undertaking so ambitious an enterprise Dr. Wieder is doing a great service to students of early maps. The style of the reproductions is of the best class throughout, and the only criticism to be suggested of the general form of the publication is that in order to avoid folding the maps the size is unwieldy, rendering the work somewhat awkward to consult, while its suitable housing will tax the resources of most libraries, public or private. Since the above notice was prepared, a second portfolio, containing matter of even more importance than the first, has been received. We hope to notice it later.

E. H.

REVIEWS

THE ANTIQUITY OF MAN IN EAST ANGLIA. By J. Reid Moir. *Cambridge: University Press* 1927. 9×6 *inches;* xiv+171 *pages; diagrams and illustrations.* 15*s*

In contrast to some other books lately published, this admirably written and illustrated book advances our knowledge many parasangs. The author puts together the results of long years of careful excavations by himself and others, and shows their relation to general knowledge on the antiquity of man. Though treated scientifically, the subject is envisaged in a human way which will make it interesting to the ordinary educated reader. The romance of spade work could hardly be more richly illustrated than by this account of human artifacts preserved in a series of deposits in the dry, sandy districts of E. and N.W. Suffolk and Norfolk. On the surface, in sections of brickfields and cliffs and of the beach, especially on the N.E. coast of Norfolk, have been found irrefragable evidence of the "stupendous history of man upon this planet" extending over something like a million years.

The main interest of these pages certainly lies in the geological stratum called the Suffolk bone bed found some 35–40 feet down under the shelly sand of the Red Crag, containing bones of tropical animals in association with flint implements, the earliest and most primitive known to science. Some of these closely resemble the much-discussed eoliths found by Mr. W. B. Harrison in iron-stained gravel on the north slope of the North Downs in Kent—implements with two flattish surfaces, about half an inch thick, with edges flaked, the flaked portions being of a dark mahogany-brown colour. They were, in all probability, shaped some half a million years ago by ape-like men who lived in a tropical climate among great beasts of prey on the land surface of the great Wealden dome. The pre-Red-Crag implements of Darmsden, in Suffolk, comparable only with those found in Kent and at Puy Courny in Central France, Mr. Reid Moir personally inclines to think, belong to the end of the Miocene Age at the close of the Tertiary Period. From these primitive beginnings copious evidence shows an orderly development of flint implements to the latest symmetrical forms in use at the end of the Stone Age. Along with the Icenian flints found at Bramford, which are an advance on the Darmsden eoliths, were found pieces of man-shaped bone which Mr. Moir claims as "the most ancient bone implements yet discovered." He proceeds to trace, from the point of view of East Anglian finds, the evolution of flint implements through all the Stone-Age periods, and rounds off the subject with a brief review of the Bronze, Early Iron and Roman periods—a very effective story of "man's gradual ascent from the lowliest beginnings." Pages 9–13 deal with the vexed question of flints as artifacts or as Nature's work. Whereas "it is very difficult, if not impossible, to tell in every case if any single flaked flint of a primitive or simple type is the result of human intention or natural fracturing," the evidence is satisfactory if we have a large series from any given locality, especially in association with flakes, hammer stones, animal bones, ancient fires, or—best of all—a whole skeleton or skull. All students of flint implements will be indebted to Mr. Reid Moir for his excellent presentation of the finds in East Anglia. Two minor corrections only may be offered: p. 123, the end-of-line division, Pithecanthropus, is unhappy; and in letterpress to Plate XXII *late* should be *early* Bronze Age.

S. E. W.

LES PLATEAUX DU JURA CENTRAL: Étude morphogénique. Par GEORGES CHABOT. *Publications de la Faculté des Lettres de l'Université de Strasbourg, Fascicule* 41. *Paris: Société d'Edition: Les Belles Lettres* 1927. 10×6 *inches;* 350 *pages; illustrations, diagrams and maps.* 12*s* 6*d*

This is a detailed and comprehensive work on the central plateaux of the Jura. It is divided into four parts dealing in turn with the Ornans peneplain and surrounding features; the first cycle of erosion (démantèlement) and the dislocation of the peneplain; recent sub-aerial evolution; and Karstic phenomena together with the evolution of closed basins. The volume also contains a full bibliography, and a useful and interesting appendix on terms used to define certain features of Karsts. Unfortunately, it suffers from a defect common in foreign works—it has no index.

Students acquainted with the areas treated will find the work of much interest. But for the general reader there is also a great deal of valuable material. This is particularly true of the latter half of the book. Some nice details of river development, applying to the Doubs, Loue and Lison, will appeal to those interested in rivers. But perhaps the most useful part of the book for the geographer who has no special knowledge of the Jura is that dealing with the Karst-like features.

These are discussed at some length, and the treatment is such that it makes a fairly comprehensive approach to the study of the evolution of limestone areas in general. The Jura Karst areas have their own peculiar characteristics and are compared with those studied by J. V. Daneš in the Tropics and J. Cvijić in Europe. The modifications of the Jura type are shown to be very largely dependent on (1) the less thickness and purity of the limestone beds compared with the Karst proper and their relations to the marly beds; (2) the climate, which is practically West European in type and so very different from that of the Karst proper; and (3) the folded nature of the Jura beds. Other local details are shown to bear a close connection with the extension of the Quaternary Glaciers.

The book is not very attractively produced and some of the text-figures are rather rough—in one case there is slight discrepancy between figure and text. These however are minor points and do not detract from a useful volume.

J. A. S.

HOMER'S ITHACA: A VINDICATION OF TRADITION. By Sir RENNELL RODD. *London: Edward Arnold & Co.* 1927. 8×5 *inches;* 160 *pages; illustrations and maps.* 6*s*

The writer of this breezy little essay is on familiar ground in Greece. Even more familiar to him is the text of the *Odyssey;* he has discussed the "Dörpfeld theory" of Ithaca with its inventor, when the theory itself was new; and his actual introduction to Ithaca was (as is proper) by small sailing vessel, with time at his disposal, and the best of goodwill among his Ithacan hosts, whose love of Ithaca and world-wide wanderings recall old times. The argument opens with "some postulates," literary rather than critical, with which few nowadays will quarrel: "a great creative genius cast the story in the form in which it has come down to us" (p. 43); and the *Iliad* is near enough to the *Odyssey*, as literature, to be relevant commentary on that story and its incidents. Some would go further, and claim greater antiquity and closer relevance for the "Catalogues" in *Iliad* ii and xiii than is postulated here.

But did "Homer" know the topography of Ithaca, either from contemporaries or his own experience? The argument, here stated, is cumulative,

first that the theory of a wholesale shift of place-names makes more difficulties than it solves, and (in particular) disregards Homeric evidence about Leukas, where the crucial place-name "Nerikos" has not shifted at all, and about Doulichion, and the "sharp islands" inshore, which are shown to determine precisely the course of Telemachus' homeward voyage; *second*, that the traditional topography alone corresponds with the spread of the new occupants to whom Odysseus' family belonged; a fresh and valuable observation. Round the major conclusion that Homeric Ithaca *is* our Ithaca, the topographical details are shown to cohere fairly well:—the township at Polis; the home of Odysseus somewhere on the slopes above it; the farmstead of Eumæus near the only conspicuous cliff, on the south-east side of Merovugli; and the "Harbour of Phorkys" probably at Dhexia, though the "Cave of the Naiads" is rather farther inland than the poem describes it. Though in all this there is not much that is new, the value of a fresh judgment, so carefully based on eye-witness, is obvious; and the detailed notes on the traces of old settlements are an implied challenge to another and more expert Schliemann. For the fact that Dörpfeld found a settlement where he looked for it proves nothing against sites where he did not excavate. J. L. M.

TWO VAGABONDS IN ALBANIA. By JAN GORDON and CORA J. GORDON. *London: John Lane* 1927. 10×6 *inches;* xii+304 *pages; illustrations.* 12*s* 6*d*

Though quite unpretentious, written without any parade of geographical or even of topographical knowledge, and accompanied only by two rough sketch-maps, this book gives so illuminating an account of present-day Albania that no geographer interested in Balkan problems can afford to neglect it. The authors' journeys, made in the summer of 1925, covered a wide range, particularly in the south, for the visit to the Albanian Alps was short. As they have already made abundantly clear in their other books, they are remarkably indifferent to comfort in travelling, and very resistant to fatigue, two very important qualifications for the wanderer in Albania. Their intense interest in mankind and in varying ways of life, an interest untinctured by any desire to impose their own standards on others, makes them invaluable guides in a region where few travellers have been able to display similar detachment. They took the trouble to learn some Albanian before entering the country, and their book, alike in its text and in its sketches, gives the impression, so rare in Balkan books, of being a reproduction of facts of observation on the part of keen and observant travellers, interested in men and women as they are and not as they might be. No attempt is made to depict the abstract Albanian, but the book is filled with wonderfully vivid presentations of actual Albanians, particularly of those returned emigrants from the United States, who have learnt so little of value and forgotten so much, and form in themselves one of the difficult problems of the young state. Though it is no part of the purpose of the book to prophesy the future, it is made clear from many conversations that the more thoughtful of the Albanians themselves are doubtful of the country's power to carry out the task of nation-making without outside help. M. I. N.

BALKAN SKETCHES: AN ARTIST'S WANDERINGS IN THE Kingdom of the Serbs. By LESTER G. HORNBY. *London: Brentano's Ltd.* N.D. 10×7 *inches;* xvi+224 *pages; illustrations and sketch-map.* 21*s*

The title of this book is probably intended by its artist-author to be decorative, rather than a crude statement of fact. He took a steamer down the east coast of the Adriatic, visiting the coastal towns, including that which has sprung

up in and around Diocletian's Palace. (This, for some obscure reason, he habitually calls Spĺato, though it is correctly spelt on the accompanying map.) He made also the regulation excursion to Mostar and Sarajevo, with a visit to the source of the Bosna, and generally seems to have limited his wanderings to the area within which the Austrians took much trouble to smooth the path of the tourist. A delightful region it is, and its beauties are well brought out by the author's sketches, many of which seem to us exceedingly good and showing real feeling for the landscape. If to the geographer it is something of a shock to find Dalmatia regarded as part of Serbia, and Yugoslavia as an "ancient nation," the reply seems to be that to the author, whether as American or as artist, prosaic details in regard to a land thought of as unknown are of no significance. The nature of his real interests is such as to make comment on his text in a geographical journal unnecessary. M. I. N.

THE GREAT EARTHQUAKE OF 1923 IN JAPAN. Edited by MORIHIKO FUJISAWA. 2 volumes. *Bureau of Social Affairs, Home Office, Japan* 1926. 9×6 *inches;* xxvi+616 *pages; diagrams and maps separately*

PHYSIOGRAPHICAL STUDIES OF THE GREAT EARTHQUAKE of the Kwanto District, 1923. By Prof. N. YAMASAKI. *Journal of the Faculty of Science, Imperial University of Tokyo, vol.* 2. *pages* 77–119. 1926

During the four years that have elapsed since the great earthquake, many important memoirs have appeared, some of which have been summarized in this *Journal* (vol. 63, 1924, pp. 241–243; vol. 65, 1925, pp. 41–61; vol. 70, 1927, pp. 390–392). The reports of the scientific and building subcommittees fill six volumes of the Reports of the Imperial Earthquake Investigation Committee. These are all written in Japanese and, with one partial exception, are sealed books to English readers. It is to be hoped, however, that in time all the more important sections will be translated, in addition to Prof. Yamasaki's interesting physiographical studies, which throw such welcome light on the origin of the earthquake and on the remarkable deformations in the bed and surrounding coasts of Sagami Bay.

The river Sakawa runs in a general south-easterly direction into the north-west corner of Sagami Bay. Prof. Yamasaki shows that its valley is a rift valley formed by the subsidence of a block between two parallel faults. The rift valley is continued beneath Sagami Bay, the greatest depth reached being about 2000 metres. During, and perhaps partly after, the earthquake, the floor of this rift valley subsided from 100 to 210 metres, while the blocks on either side were uplifted, by as much as 120 metres on the south-west side and 250 metres on the north-east side, the latter block being also tilted towards the north. The shelf in the shallow water near the coast was uplifted, but by a much less amount, and tilted towards the north, until, near Tokyo, the elevation gives place to a slight but widespread depression. The earthquake, as Prof. Yamasaki concludes, was the direct effect of an enormous blocking movement, repeated as a rule along old dislocation lines.

The official history of the earthquake, compiled by the Home Office, was published in Japanese in 1925, and, after revision, has since been translated into English. It is a record of the greatest value, written from an historic or economic, rather than from a scientific, point of view, for it does not attempt to add to our knowledge of the phenomena or cause of the earthquake. One point of considerable interest may, however, be gathered from it. The volcanic island of Oshima lies close to the south-west scarp of the submarine rift valley, yet, out of more than two thousand houses in the island, only eight collapsed,

chiefly from landslides, and forty-one were partially destroyed. The slight loss of life on the island was caused by the subsequent sea-wave. With the help of many admirable illustrations, the history gives a vivid account of the effects of the earthquake and fires, of the abrupt cessation of the ordinary modes of life, of the strange existence forced upon all classes during the following weeks, and of the measures rapidly devised for the relief of the survivors. Later chapters consist largely of tables giving the loss of life and property in Tokyo, Yokohama and other districts, and the destruction of libraries and works of art. The total number of persons killed and injured is given as 156,693, more than 67,000 of the deaths being in Tokyo alone. The value of the property destroyed, according to the latest and most trustworthy estimate—that made by the Statistical Department of the Tokyo City Office—is 5506 million yen, or about 550 million pounds. C. D.

NIGERIA UNDER BRITISH RULE. By Sir WILLIAM NEVILL M. GEARY, Bt. *London: Methuen* 1927. 9×6 *inches; 312 pages; portrait and map.* 16*s*

Sir William Geary practised as a barrister in Lagos from 1909 to 1913. His duties necessarily prevented his gaining an intimate knowledge of the great world outside the capital. This and a tendency to over-free expression of personal opinion have led to faults which mar a book which would otherwise be a very valuable addition to West African literature. To this is added the contempt of a Lawrence for the spelling of geographical and personal names which in a book of an historical character is not easily forgiven.

Kontagora, for example, is repeatedly referred to as Kantagoro, and its former emir is called Germachi (p. 215) instead of N'Gwamatche. The Kwa Ibo river (p. 101) becomes both Kua Ibo and Qua Ibo in the space of four lines later on (p. 120). We have a Nicols and a Nicholls apparently figuring as the same man on p. 74. The victims at Bassa in 1903 were Reardon and Amyatt-Burney and not "Riardon" and "Amyatt-Barnes" (p. 221). Nor did W. E. L. Temple write either 'Native Races and their Rulers' or 'Notes on the Northern Provinces of Nigeria.' The former is by C. L. Temple and the latter by O. Temple. This list might be considerably extended.

The author, however, has rendered a service to Nigeria by bringing together into one volume the eventful history of British rule in that great dependency.

The story begins in 1851 with the bombardment and capture of Lagos, then a stronghold of Portuguese and Brazilian slave traders. Having carried the history of Lagos up to 1906 Sir William gives us an interesting chapter on the early days in the Niger Delta. The trade in slaves and palm oil, the important rôle of the coastal chiefs as middlemen, the appalling wastage of human life in the trading ships, hulks and factories are all well described.

The difficulties of Consular Government are well brought out in a chapter on the Niger Coast Protectorate. The unfortunate Ja-Ja incident, in which Sir Harry Johnston played so prominent a part as a young man, rightly belongs to this period, and it is narrated at considerable length in an appendix to which are added letters from some who were personal friends of Ja-Ja. The story of the Benin massacre is retold, and the vast scale on which human sacrifice was practised by the forest tribes is further described in the account of the famous Long Ju-Ju of the Aros.

The difficult task of opening up the interior which had been commenced by Lander was carried on by McGregor Laird and Dr. Baikie. These pioneers were followed by the servants of the Royal Niger Company whose charter was granted in 1886. The company appears to have been ill-advised in the policy

of secrecy which it enforced on its servants. Apart from the loss it entailed to science—for the most part only temporary—it freed the company from the healthy restraints of public opinion and effectively hid the blunders and abuses of its servants. In spite of the advantage of its monopoly the company's trading profits were never excessive. It conscientiously observed its obligations, which were considerable, and undoubtedly rendered very valuable service to the cause of imperial expansion at a time when, in spite of the jealousy of other powers, the British Government was unwilling to incur fresh commitments. The company's charter was revoked in 1897, when the need for effective occupation by the Government could no longer be resisted.

The story of the advance into the northern emirates naturally centres round the remarkable personality of Sir Frederick (now Lord) Lugard. Lack of revenue and consequently of officers led him to evolve the system of indirect rule which will ever be associated with his name. The proof of his wisdom was forthcoming after the Satiru disaster. Although a tremendous blow had been struck at our authority only three years after the fall of Kano and Sokoto, yet the powerful emirs of the north succoured the survivors, and, rallying their own forces, spared no effort to re-establish the prestige of British rule. Since then the history of Nigeria has happily been one of ever-increasing prosperity, the economic side of which is fully dealt with by Sir William Geary.

There is so much of value in the book that it merits careful revision. Any future edition would be improved by a more logical arrangement of subjects, and should include a better index, a more generous provision of maps and a bibliography not restricted to official and semi-official publications.

E. W. B.

ANNUAL REPORT OF THE TOPOGRAPHICAL SURVEY OF Canada for 1926. *Ottawa: F. A. Acland* 1927. 9×6 *inches; 32 pages; illustrations and maps.* 10 *cents*

The Topographical Survey of Canada is increasing its sphere of duties and its output. It is true that in spite of its rapid development Canada does not touch the output normally reported by the Survey of India, but it is equally true that the steady progress augurs exceptionally well for the future.

As is to be expected from a department whose original task lay wholly in Dominion lands, the bulk of the output refers to the prairie provinces. The surveys on which the mapping of Canada depend are topographical and photographic. Ground photo-topography has been responsible for a considerable area in the Rocky Mountains, normal topographical methods have been used on the Prairies, in Ontario, Quebec, New Brunswick, and Nova Scotia, whilst air phototopography has taken a leading and interesting part in the small-scale mapping of the Laurentian Plateau. It is curious to notice that, in talking of control, details of traverses and lines of levelling are given, whilst there is no mention of triangulation.

The air photo-surveys were conducted mainly by that oblique method framed by the late Dr. Deville, and carried recently to considerable perfection. It is curious and interesting how Canada lends itself to the camera: on the one hand we have the Rockies in which ground phototopography finds so natural an outlet, and on the other hand those enormous plains, almost as much water as land, and with practically no significant accidents of the ground, which form the ideal country for oblique photography from the air. In addition to these advantages of topography, Canada also boasts a climate and atmospheric conditions singularly favourable in the field season to photographic work. The report might confuse those who are not yet well acquainted with methods of

air phototopography. The oblique method is successful in Canada because the water surface is visible far into the background of the photograph itself. These same circumstances will seldom be met with in other parts of the world, though there is a possibility in the Sudd region of the Sudan. It is interesting to read that this method can be based upon unconnected portions of control laid down here and there to suit the actual photographs taken. It is an axiom, of course, that the best method of survey is that which gives the required accuracy at the minimum cost. All methods of surveying from air photographs have suffered in the past from a reliance upon a dense and rather unnaturally framed ground control; it is this difficulty which has prevented the adoption, to any large extent, of the various, and sometimes elegant, methods and machines obtainable on the Continent. It is to be hoped that experiments in dealing with vertical photographs, both by machine and by less precise radial methods, will enable us to limit also the amount of control we use in that connection.

The report gives evidence of continued progress in a land classification which has recently been illustrated by an interesting series of maps; of the magnetic surveys, and of the research and measurement of a physical testing laboratory.

We congratulate Canada on the sound growth of her surveys, and we congratulate the Director of the Topographical Survey upon his excellent report.

H. S. L. W.

THE COLONIZATION OF NEW ZEALAND. By J. S. MARAIS. *Oxford: University Press* 1927. 9×6 *inches;* xii+384 *pages.* 15*s*

The colonization of New Zealand presents many interesting features. The competition of England and France in the Pacific, the influence of the missionary societies at home, the indifference of the Colonial Office, the activities of the New Zealand Company, the presence of a powerful native race in the islands, the attempt to apply the famous Wakefield system, and the problem of governing a distant and free colony, form the main threads of which its history is made. It is strange that these fruitful fields of our imperial history have been left so long undiscovered or uncultivated by the historian. A beginning has now been made. Dr. A. J. Harrop, in his 'England and New Zealand,' published in 1926, related from the original sources the general history of the foundation of New Zealand, and Dr. J. S. Marais, in the work before us, has made a more complete study, from the point of view particularly of colonization and government, of the first years of the settlements.

Dr. Marais begins with the situation in Great Britain, describing the views of the Colonial Reformers of 1830 and their opponents, the missionaries and the Colonial Office. He tells the story of the foundation of the New Zealand Company and its first efforts, following the fortunes of the pioneer settlements in their early years of struggle. He studies very carefully the application of the Wakefield system and indicates its beneficial results, but his conclusion is that it "had broken down completely—both economically and socially—at the first attempt of its exponents to apply it in its entirety to the foundation of new settlements." And the main reason, as he explains, was not certain special difficulties that arose in New Zealand, but that the system was "quite inapplicable to colonies which are run on the subsistence basis." None the less had Wakefield's ideas and enthusiasm inspired attempts that succeeded, though not on his lines.

Leaving the social and economic history Dr. Marais next takes up the story of political development and discusses the character and work of the first

governors, their native and land policy, and the evolution of a constitution. "New Zealand," he writes, "was started on its career with an inexperienced governor, with incompetent officials, and without provision for its Defence," and for some years it was the scene of an experiment in the art of native government no less than in the art of colonization. He carries the story of native policy and of constitutional development down to the departure of Governor Grey in 1853, and concludes the book with a study of the foundation of the last two colonies, the religious settlements, Otago and Canterbury.

It is not possible to do more than make this brief survey of the scope of Dr. Marais' work. But it may be added that the book is a very able and substantial contribution to the history of New Zealand and of the British Empire, showing a strong and thoughtful grasp of the subject and giving a careful analysis and discussion of the problems in the founding of the New Zealand colonies. The addition of a map would have been welcome, for the book may well be read by many people who have not a very exact knowledge of New Zealand geography, and geography was of the essence of New Zealand's problems. E. A. B.

THE EXPANSION OF EUROPE. By RAMSAY MUIR. Fourth edition. *London: Constable & Co.* 1926. 9×6 *inches;* xii+380 *pages; maps.* 12*s*

Professor Ramsay Muir's 'Expansion of Europe' has now reached its fourth edition, and in his brief preface the author expresses his surprise that a book originally conceived as a sort of glorified war-pamphlet should have shown so much vitality. By rewriting for the present edition the two chapters which trace the history of Europe from 1878 to the outbreak of the Great War he has tried "to free the book from the symptoms of war fever and to set forth a saner and more balanced view . . . of those causes of war which can be traced to extra-European events." Every year has given us new knowledge of the course of events in those thirty-six years, but it is rather the calmer tone and larger perspective of increasing distance from those events which he has, not without success, endeavoured to introduce into this edition. The special value of the book is that it gives a comprehensive and suggestive treatment of a large subject seldom treated as a whole, and that it places British expansion in its relation to the expansion of other European countries. A lucid style and a gift for generalization make the book always interesting, but owing to the circumstances of its origin it is too much dominated by the late war. E. A. B.

CAPTAIN JOHN SMITH. By KEBLE CHATTERTON. *The Golden Hind Series. London: John Lane* 1927. 9×6 *inches;* 286 *pages;* 8 *illustrations.* 12*s* 6*d*

This volume of the "Golden Hind" series deals with the life and adventures of that always rather obscure but romantic personality, Capt. John Smith. Originally of Willoughby in Lincolnshire, young Smith began his rovings at the age of sixteen, and ended them with the abortive second expedition to New England, when, after being forced into vicarious piracy, he returned to settle down to writing until his death at the age of fifty-one in the year 1631.

The chief interest attaching to the life of this cheerful adventurer is due to his intimate connection with the struggles of the early British settlers of Virginia, following the ill-fated attempts of Raleigh to found a permanent colony. As one of the founders and at one time Governor of the Jamestown settlement, for which he fought bravely for over two years; as the negotiator on behalf of the half-starved colony with the powerful chief Powhatan, and the recipient of the kindness of young Pocahontas, John Smith has a legitimate claim upon history, apart from his later work of exploration along the coasts of New

England. His services as a propagandist of British "plantations" in North America, for the fifteen years of his life following his last voyage, seem to have stimulated optimism even after many failures and considerable financial loss had depressed public opinion, and probably aided in bringing about the sailing of the *Mayflower*; for although he was doomed to repeated disappointment as regards renewed employment in active colonizing work, he was indefatigable in publishing accounts of his varied experiences. If many of Smith's adventures remain without sufficient corroboration, despite repeated searches into records of the day, this haziness hangs chiefly over the Eastern exploits with which we are least concerned; the tales of the lady Tragbigzanda and the three Turks' heads are unimportant compared with the story of the early settlement of Chesapeake Bay and the first European encounters with indigenous American tribes. The records of the repeopling of North America are matters of lively interest on both sides of the Atlantic.

The author would have presented a more vivid account had he quoted more freely from Smith's own copious and picturesque writings. Strongly partisan, Mr. Chatterton continually commits the fault of over-lauding his hero, while labelling all Smith's associates as cowards, drones, and rabble of the worst type. He protests too much, in fact, for whatever the virtues of this hardy and resourceful explorer, he was far from faultless.

Mr. Chatterton's diction is frequently careless. "Since fear of disgrace could not enthuse them" is poor English enough, but in many sentences (as: "In order to get the correct emphasis, we cannot omit from our consideration to note that from the seventeenth century there comes into nautical history, with a much stronger importance than ever, the industry of fishing") he becomes choked with words.

The volume is agreeably presented and well printed; the illustrations, chiefly reproduced from charts of Smith's times, are interesting; and the index is adequate. L. E. E.

ACROSS THREE OCEANS. By CONOR O BRIEN. *London: Edward Arnold & Co.* 1926. 9×6 *inches*; vii+296 *pages*; *illustrations and maps.* 16*s*

It is a common saying among "sailors and other disreputable persons" (to quote an unfortunate phrase once used by a West-country newspaper) that you must sail round the world to win the right of nailing a shark's tail to your flying-jibboom. That a higher class of this singular decoration has not been established for those mariners who have made their circumnavigation single-handed, or nearly so, is due, in all probability, to the very limited number who have performed this amazing feat of seamanship. The Press reminds us almost daily that the world is steadily growing smaller, and a time may come when sailing alone around the world will be regarded as an exploit no rarer or more difficult than that of (actually) swimming the Channel. Hitherto, however, only one man has accomplished it—the late Capt. Slocum, in the *Spray*—although two similar attempts are now in progress. *Proxime accesserunt* must be placed against the names of the late Lieut. G. H. P. Muhlhauser, R.N.R., and of Mr. Conor O Brien. The latter's recent circumnavigation of the world in his yacht *Saoirse* was made, like Muhlhauser's in the *Amaryllis*, with the dubious assistance of a very small and scratch crew whose composition was continually varying; and its successful completion, signalized in a striking manner by the return of the *Saoirse* to the same moorings off Dunleary which, two years earlier to the second, she had let go, stamps Mr. O Brien as a first-class seaman gifted with uncommon tenacity of purpose. Any reader of his book—and such will undoubtedly be numerous—will immediately discover

that he is many other things as well: a navigator, a rigger, a shrewd observer of men and things, a writer with a highly individual and descriptive style, a philosopher and, last but not least, an Irishman—a fact attested, *inter alia*, by his characteristic description (p. 40) of the pilot-fish's method of following ships: namely, by keeping six inches in advance of them.

The *Saoirse*, a 20-ton ketch-rigged yacht with a freeboard of something under 2 feet, left Dunleary on 20 June 1923, manned by a crew consisting of her captain, a mate, and an A.B., the two latter having signed articles for a voyage "to any part of the world, terminating . . . within two years"; a stipulation which, so far as the ship and her captain were concerned, was, as already remarked, most punctiliously fulfilled. The voyage was made east-about (the *Spray* and *Amaryllis* went westward), the ports of call being Madeira, St. Vincent, Pernambuco, Cape Town, Durban, Melbourne, the Falklands, Pernambuco, Fayal, and so home.

As may well be imagined, it was far from uneventful. It became necessary to have a new mast stepped at the Cape, and scamped work in connection with this brought a crop of troubles as soon as the *Saoirse* put to sea again: at the same time it was discovered that a Cape "shoptician" had let the chronometer stop while in his charge, and concealed the occurrence by returning it with a false rate: the crew deserted on reaching Melbourne, and were temporarily replaced by three Tasmanians, who on sailing became and remained sea-sick passengers; real seamen, everywhere, were hard to find and harder to keep; the steering-chains carried away at midnight in mid-Pacific—but space is lacking for any abstract, however brief, which could do justice to all the "faites et gestes" of *Saoirse* and her captain (which included, *mirabile dictu*, the taking of a lunar). Let it suffice that Mr. O Brien was fortunate in picking up a Tongan hand, one Kioa, at Nukualofa, who "swore he would go to the end of the world with me, and very notably did so"; that in the early days of December 1924 a 20-tonner, without auxiliary, rounded Cape Horn as nonchalantly as though she had been running up the Solent; and that her ultimate arrival at Dunleary among "the cheering of crowds, the playing of bands, the making of speeches," followed by a "procession to Dublin headed by Neptune and Amphitrite in an allegorical car" signalized, among other matters, the covering of 31,000 miles in 280 sailing days, and drew from her captain the quiet comment, ". . . it is good to have sailed round the world in order to be at home again."

The book is redolent of its author's cheery personality, and exceedingly amusing for that reason.

To his account of the voyage Mr. O Brien has added a most valuable and informative chapter on ocean cruising, and an abstract of *Saoirse's* log. Unfortunately, there is no index.

As regards the illustrations, some are from snapshots, and good of their kind; there are also some very clear diagrams of *Saoirse's* rig and the alterations made in her masting and gear. There are three small outline maps, designed merely to elucidate the text. For the same purpose, the book's end-papers are composed of two similar maps, on a sort of "tipcat" projection (cylindrical for the tropics and conical elsewhere), showing the outward and homeward halves of the voyage.

It remains to be added that for his performance in *Saoirse* Mr. O Brien was awarded, three years in succession, the Challenge Cup of the Royal Cruising Club—a well-merited honour. R. T. G.

THE MONTHLY RECORD

TYPES OF ENGLISH VILLAGES

The general problem of the distribution of rural population has lately been referred to in the Record (*G.J.* 70, 186). Mr. William Page's paper in *Antiquity*, December 1927, on types of English villages and their distribution, deals with some limited aspects of the subject. Mr. Page treats only of "nucleated" settlements largely in Eastern and South-Eastern England, and though avoiding definite conclusions, he inclines to associate them with the Teutonic invaders. His main subject is the relation between settlements and lines of communications. In general, traders would settle on a main road, while farmers preferred to be some distance away, using roads and rivers as boundaries of their settlements. This latter type, of which Bygrave in Hertfordshire on rising ground clustering round church and manor, is a good example, has naturally been better preserved. In north and east Kent the early English settlements are found on fresh sites along the rivers and Roman roads, probably because the Jutes were traders who may well have been previously acquainted with Roman methods. Farther to the south and west, where the country was forested, progress slower and development later, the settlements are on subsidiary roads. In Sussex rivers seem to have been preferred to Roman roads. The middle and east of England show nucleated settlements off the line of communication. The invaders employed the rivers in their migrations, and later Roman roads or new tracts: from the mouth of the Trent their settlements, at a distance of approximately a mile on either side, can be traced through Nottinghamshire and Leicestershire. South of the Isle of Axholme the parish boundaries, which may be taken to represent lines of original settlements, show that probably the land between the Trent and the Old Ancholme was divided only into two lines of settlements, and that in the determination of boundaries Ermine Street was ignored until Kirton in Lindsey was reached. Here the settlements appear to have been arranged methodically, standing back 1 to 3 miles from the road, upon which they have regular frontages of about 1 mile. Between these aligned settlements others of irregular shape were interposed, probably by later squatters. Similar arrangements may be observed south of Lincoln, and also in the Fens along the river Glen. Where these alignments can be shown to exist it may be assumed that they mark the routes of the invaders. Roman roads were generally used only when they supplemented a system of natural waterways, and Roman towns were also avoided. A development of this nucleated settlement off the road is the village which has migrated to the road, to share in its traffic. Examples, due to Danish stimulus, are found in Hertfordshire and Essex, often distinguished by the epithets "Great" and "Little." Another type is the "ring fence" plan—the clearing encircled by the road—found in former forested areas of Middlesex, Surrey, etc. Though the clearing has often been built over, unless it survives as the village green, its outline may still be traced. Another type of later origin is the town with the road broadening into a V-shaped market-place, as in St. Albans and Hitchin. Other types, referred to but not described in detail, are the bridge-head or double town, the grid-iron and the spider's-web plan.

AN EARLY MS. MAP OF THE RHONE DELTA

In pursuing his researches into the changes to which the Rhone delta has been subject within the limits of history (see *G.J.* 65, 403 *et seq.*) Mr. R. D. Oldham has discovered in Paris an interesting manuscript map of that are

which though undated is clearly of the first half of the seventeenth century, since it shows the Tour de Tampan, built in 1606, but not the Tour St. Genest, by which the former was superseded in 1656. Mr. Oldham has kindly presented a photograph, on exactly half the scale of the original, for inclusion in our map collection. The map is carefully drawn and the detail shown is unusually full for so early a period, the map being evidently based on trustworthy information. It is interesting as having been made shortly after the great changes which took place in both branches of the Rhone in the latter part of the sixteenth century and before the old courses had been obliterated. The old channels of both branches are shown as well as the new. Mr. Oldham has also supplied a tracing in which the main features of the hydrography as represented in the old map are superposed on the modern outline. The original map is preserved in the Depôt des Cartes de la Marine, Portefeuille 73 *bis*, Div. 12, Pièce 1.

NEW MAPS IN MONGOLIAN CHARACTERS

The Society has recently received from the Representative of the Mongolian Ministry of Public Instruction residing in Berlin a pair of physical and political wall maps of Mongolia on the scale of 1/2,000,000, a map of the world in hemispheres in two sheets, each measuring 3 by 3 feet, and a general school atlas of 12 pages of physical and political maps, all of which are intended for education in Mongolia, and are interesting as being the first efforts of the country in cartography on modern Western lines.

According to a note forwarded with the maps the newly constituted republic is turning its attention to the question of education, and the creation of the means of instruction is being carefully considered by the national government, one of its important tasks being the preparation of geographical maps and atlases. All the maps received are printed in colours, and on most of them the relief is shown by layer tints combined with hachures. They are bold and diagrammatic in form, and although there are some differences, in general the physical features on the maps of Mongolia agree with those to be found on other maps; but the territorial divisions vary considerably from those usually indicated.

The accompanying note states that the preparation of all geographical works has been placed by the Ministry of Public Instruction in the hands of the Mongolian Scientific Committee, which has not only undertaken the production of maps, but is arranging to send out annual exploring expeditions to the less-known parts of the country, so that the mapping may become more accurate.

The actual drawing and lithography of the maps received were carried out by Messrs. Wagner & Debes, of Leipzig, working under the general instructions of Mr. Batu-Chan during his stay in Germany in 1926. The proper rendering of the place-names and geographical terms into Mongolian was a matter of considerable difficulty, and was undertaken by a special Commission of the Scientific Committee under the direction of Mr. Shanzarano.

RIO LOA, NORTHERN CHILE

A detailed account of the special features of a river basin in North Chile is given by Mr. W. E. Rudolph in the *Geographical Review* for October 1927. The river is the Rio Loa, the only river to reach the sea throughout the year on 600 miles of desert coast. The permanent population of the basin consist of six small agricultural communities, mainly Indians with some Spanish blood, not more than 2500 in number. At one time, however, there was a

population of 40,000 working the nitrate deposits, though these have declined greatly. The *régime* of the Loa is therefore of great importance. Unfortunately, below Chiuchiu the river water is not drinkable, so that to Quillagua, for example, 3000 gallons of fresh water per week are brought by rail. Irrigation has been practised since pre-conquest times, though again in some cases the water is too saline for agriculture. The Chilean Government has regulated the use of the water, drinking-water being limited to supplying cities, mines, etc., and locomotives, the saline water for refining nitrate, industries including mining, irrigation, and hydro-electric power, in that order. In the Loa basin capital expenses are very high for irrigation works and almost prohibitive of power installations. At present, only half the surplus water is used for agriculture, but further developments are possible with the decline of the nitrate industry.

The physiographical characteristics of the basin, in common with the Andean system, have resulted from late Tertiary volcanic activity, followed by subsidence and block-faulting, producing large basins, many of interior drainage. The northern Loa flows through such a depression. Recent enormous elevation of the whole area, the beginning of the arid climate, and renewed volcanic activity, have produced the present features of deeply cut canyons intersecting older and shallower drainage systems. The sources of the Loa lie among the practically extinct volcanoes, and several of its tributaries, particularly the Rio Salado, flow from geysers and hot springs. The Salado is excessively saline, and it has been proposed to divert its water into an evaporation basin to lessen the salinity of the Loa. At the Salado–Loa confluence, the river is at its peak ; later there is considerable seepage through the limestone, some of which is returned by tributaries. Irrigation also draws off water, but a considerable proportion of this is returned. At Chiuchiu, for example, 80 cubic feet per second is utilized, but of this about 56 cubic feet return to the river. Lower down at the 4500-acre agricultural settlement at Calama, about half the flow is used for irrigation. The greater part of the river's water is derived ultimately from the snows of the Cordillera, for over three-quarters of the basin rain showers are only of rare occurrence. On the higher slopes, however, a little rain falls. At San Pedro station (10,570 feet), 1·42 inch and 1·96 inch were recorded in 1917 and 1918 respectively. The evaporation is also great, that for one day being said to equal the precipitation of ten years. Between the two ranges of the Cordillera where the tributaries rise, there is an immense basin filled with gravels and sand which acts as a reservoir ; the flow of the river, daily and seasonably, is therefore fairly constant. Although the summer, when the rain should fall on the Cordillera, is often very dry, yet during the following months no such variation in the river's flow as might be expected is observed. Mr. Rudolph believes, therefore, that some underground supplies reach the springs from the enclosed lakes of the Bolivian *altiplanicie*, and that at an earlier period Lake Titicaca may have drained into the Rio Loa.

THE CHICAGO REGION

The work of the Regional Planning Association in the Chicago region emphasized the lack of a base map and also of a comprehensive survey of the physiographic features. Several bodies accordingly combined to make possible this work, the result being a monograph, ' The Physiography of the Region of Chicago,' by F. M. Fryxell (published here by the Cambridge University Press). The main features of this work are the excellent coloured maps containing details not hitherto so easily accessible of an area with an approximate

radius of 50 miles from the city. The text is a simple exposition of the significance of the features they display, particularly as they affect settlement. The more important maps show relief, glacial features, and soil. These emphasize the predominant part played by the ice in the evolution of the present topography. Three concentric upland zones of morainic material trending approximately with the Lake Michigan shore-line, are separated by flat sandy plains, glacial outwash and former lake bottoms. This ring is broken through in the south-west by the "Chicago outlet," a wide pre-glacial valley now occupied by the Des Plaines river, which, though formerly probably draining to Lake Michigan, now joins the Mississippi system. The importance of this "outlet" to the development of Chicago is especially dwelt upon by Mr. Fryxell. It crosses the continental divide at a height of 15 feet only above the lake-level, and besides providing a valuable communication link, it has helped to solve the Chicago drainage problem. The area upon which Chicago stands, formerly within the area of the lake, and partly formed by the southward-drifting sand-dunes, from its striking flatness offered no obstacles to its rapid development. This very ease of growth soon emphasized the drainage problem, which has been solved only by the removal of large quantities of water from Lake Michigan and its ultimate disposal by the Chicago Drainage Canal through the "outlet." (The question of the fluctuation of Lake Michigan levels, partly from this cause, was noted in the *G.J.* 69, 595, June 1927.) The uplands of the Chicago region are particularly rich farming and dairy lands. At the same time drainage in many areas is imperfect, and these, generally forested, are being protected as natural reserves, with the swamps of the plains and the dune areas of the lake-shore.

DRIFT OF SHORE MATERIAL

In his paper on "The East Anglian Coast," (*G.J.* 69, 24, January 1927), Mr. J. A. Steers suggested various conditions under which drift of shore material takes place in an opposite direction to coastal currents or to the direction which might be assumed from the prevalent winds. On the north Norfolk coast, for example, the drift is to westward, which is not in conformity with the tidal currents, while, further, the prevalent winds are from the south-west. Mr. Steers showed that the important winds in beach changes are those from the north-east, which, sweeping across the North Sea, develop strong wave action carrying the beach to the west. The prevalent winds, being offshore, exercise little influence. Changes are therefore wrought by comparatively rare gales from the north-east, rather than by weaker continuous influences, though the "undertow" caused by the southerly winds contributes to a small extent to westerly drifting. We have recently received from Mr. Henry S. Sharp of Columbia University a typewritten record of observations on beach drift which confirm Mr. Steers' conclusions. Mr. Sharp had already contributed a paper to the *Scientific Monthly*, July 1927, which dealt with the economic aspect of the problem. The general result of his observations shows the predominant factor in each case to be those winds which cross the largest extent of open water and thus develop strongest wave action: local topographical configuration is therefore often the clue to seemingly unexpected beach movement.

Along the northern portion of the New Jersey coast, which runs approximately north and south, the drift is northwards, while on the adjacent east-west Long Island shore it is westward. In the latter case the prevalent wind is from the south-west, and eastward drifting might be expected; but in this quarter protection is afforded by New Jersey. It is the much weaker south-east wind blowing across the open ocean that is responsible for the westward

drift. Similarly on the New Jersey coast: at Sandy Hook the north-east winds are stronger, but in this quarter lies Long Island. The weaker south-east winds from the Atlantic therefore produce the northward drift.

A sharp change in direction of drift from eastward to westward has been observed at Coney Island, near Rockaway Point. Mr. Sharp explains this by the sheltering of a portion of the beach from the "dominant" south-east winds by Rockaway Point, which permits the weak south-west waves to move the beach eastwards on the sheltered stretch only.

On the north shore of Long Island Sound a further example of the importance of local position is to be found. Along this young, irregular coast there are many pocket beaches, three of which, from north to south, Meadow, Rye and Oakland Beaches, are opposite the Transport and Forlies Rocks. At Meadow and Oakland Beaches the drift is roughly northward, but in the middle, Rye Beach, it is southward. Meadow Beach is protected from the south-east wind by the Transport Rocks: the south winds being stronger than the east, beach movement is north-easterly. Rye Beach is protected from the east by the Transport Rocks, to the south-east and south by the Forlies Rocks, consequently the weaker north-east winds are able to develop wave action, carrying the beach to the south. Oakland Beach, protected by the Forlies, but open to the south-east winds, is being moved northwards. He concludes that strength of wind and length of fetch will explain beach movement formerly attributed to tidal currents.

THE CARTHAGINIANS AND THE AZORES

The question whether in their voyages beyond the Strait of Gibraltar the Carthaginians ever sailed as far as the Azores, has lately been reopened by Dr. R. Hennig, author of the book 'Von ratselhaften Ländern,' reviewed in the *Journal* for July 1927 (p. 85). He there merely mentioned the belief, held by the Swedish writer Podolyn in the eighteenth century, and subsequently dealt with by Humboldt, that the Carthaginians must have reached the Azores either by accident or design, since coins proved to be Carthaginian and Cyrenaican had been discovered on the island of Corvo in 1749. The note in which this view was put forward was printed in 1778 in a Göteborg journal of small circulation, and has therefore been almost lost to sight. After some search, however, Dr. Hennig succeeded in obtaining a photostat copy from the State Library at Stockholm, and he re-discusses the question in *Petermanns Mitteilungen*, 1927, Part 7/8, on the basis of Podolyn's note, a translation of which he supplies, together with reproductions of the drawings of the coins which accompanied it. The story of the finding of the coins, in a broken earthenware vessel laid bare by a storm, seems thoroughly well authenticated, the coins figured having been presented to Podolyn by the well-known Spanish numismatist Florez, who had himself received them direct from Corvo, and whose good faith there is no reason to question. By comparison with known Carthaginian coins they appear to date from about the second half of the fourth century B.C., and Dr. Hennig is forced to the conclusion that the arrival of at least one Carthaginian ship about that period is hereby substantiated. Podolyn attempted to support the theory by referring to the story, originally told by Damian de Goes and repeated by Faria y Sousa, that on their first arrival at the Azores the Portuguese found an equestrian statue in the island of Corvo; but there can be no doubt that this was a pure legend, possibly, Dr. Hennig thinks, copied from a very similar story in the Arabian Nights.

THE SEVEN DVIPAS OF THE PURANAS

In the *Journal* for September 1927 we printed a review of a paper by Mr. V. V. Iyer on the above subject. Mr. Iyer has since written to say that the reviewer was mistaken in thinking that three of the Puranas substitute *Gomedaka Dvipa* for *Saka Dvipa*, for the three which include the former drop out the *Plaksha Dvipa*, while all alike include the Saka Dvipa. We have referred the matter to the reviewer, who replies that his intention was to point out that three of the " authorities " quoted (two only being puranas) substituted Gomeda for Saka *in the sixth place in the series*, the argument being unaffected by the fact that Saka is included by them in an unusual position (the 2nd). Mr. Iyer also demurs to the reviewer's suggestion that the Saka Dvipa stands for the two divisions of Scythia separated by the Imaus, as all the Puranas consider the Pushkara, not the Saka dvipa, as divided by the mountain range. To this the reviewer replies that the Sakae (Sacae, Σακαι, etc.) have been associated with the Scythians from the earliest times, while in his view the range (or ranges) which divided Pushkara was not the meridional range of the Pamirs (Imaus) but one running east and west; one meaning of Pushkara in Sanskrit (a lake or pond) points, he thinks, to the lake-dotted areas of Tibet as intended by this name.

CLIMBS IN THE CANADIAN ROCKIES: ERRATUM

In Mr. A. J. Ostheimer's paper on " Climbs in the Canadian Rockies in 1926," in the *Journal* for December 1927, an error occurs on p. 563. The last sentence beginning at the foot of the page should read, " This indicates that the summer movement must be greater than the advance made in winter."

OBITUARY

CHARLES MORRIS WOODFORD, C.M.G.

All interested in the geography, natural history, and ethnology of the Western Pacific, particularly the Solomon Islands, will have heard with sincere regret of the death in October 1927 of Mr. C. M. Wōodford, long known as one of our foremost authorities on the latter group, and as the man to whom the introduction of order and settled government among the turbulent natives of the islands has been pre-eminently due.

Woodford was born in 1852, being the son of Mr. Henry Pack Woodford, and was educated at Tonbridge School. His acquaintance with the Western Pacific began when he was still a young man, he having settled at Suva, Fiji, about 1882, from which time on he lost no chance of adding to our knowledge of the people and natural productions of that part of the world. From Fiji he visited the Gilbert group as Government agent in the ketch *Patience*, and thence sent his first communication to this Society on a somewhat rapid rise of level which had lately been observed in the islands. His view soon turned to the almost unknown Solomon group as a field for research, and in 1886 (after a visit to this country during which he became a Fellow of the Society) he made the first of three successive journeys of exploration thereto, being landed from a trading ship and left for several months to pursue his investigations unaided among a people notorious for their suspicious and bloodthirsty nature. A good deal of time was spent on the large island of Guadalcanar, into the interior of which he was the first white man to penetrate for any distance, though his hope of exploring the mountains farther inland was frustrated by the hostility of the tribes inhabiting them. He brought home collections in

nearly every branch of natural history, which were worked out at the British Museum and were much praised for the excellent state in which they were received. An account of his first two visits (in 1886–7) was given before this Society in March 1888 and subsequently printed in the *Proceedings* for the same year. Later he described his experiences during these and a third visit in his book 'A Naturalist among the Head-hunters' (1890), which, modest both in style and get-up (its format was far less pretentious than that of half the ephemeral productions of globe-trotters with which our libraries are flooded) has taken rank among the best narratives of naturalist-travel and will long remain a standard authority on the Solomon group. In the same year he received the award of the Gill Memorial of the Society in recognition of the value of his work.

In 1895 Woodford became Acting Consul and Deputy Commissioner at Samoa, and in the following year, a part of the Solomon group having been made a British Protectorate, he was appointed the first Resident-Commissioner for the islands, a post which he retained till his retirement in 1914. The result of his firm yet benevolent administration was to effect a complete transformation in the conditions of the group, which settled down into a flourishing and in the main peaceable British Protectorate. His latter years were spent at his home in Sussex.

In 1895 Mr. Woodford contributed to the *Journal* an account of the Gilbert Islands, and in 1909 a note on the atoll of Ongtong Java (the Lord Howe group). In 1916 he read a paper on Polynesian Settlements in the region of the Solomon Islands, printed in vol. 48 of the *Journal*, and less than a year before his death gave us some last notes on the group in the issue for December 1926. Among other published results of his investigations mention should be made of the help which he gave to the elucidation of the early narratives of Mendaña's discovery of the Solomons published by the Hakluyt Society in 1901. As stated in the Preface by Lord Amherst of Hackney, Mr. Woodford took out with him the translations that had been made for the work, and to him the editors were indebted for most of their notes, for the identification of the places visited by the Spaniards, and for many photographs taken specially for the volumes. He also published papers in the *Journal* of the Royal Anthropological Institute, of which he was a Fellow.

In 1889 Woodford married Florence, daughter of the late John Palmer, of New South Wales, who survives him. Of his two sons the younger, Harold Vivian, was killed in France in 1915.

MEETINGS: SESSION 1927–28

Second Afternoon Meeting, 12 December 1927. Colonel Sir Charles Close, President, in the Chair

Paper: Gravity Survey by Submarine *via* Panama to Java. By Dr. Vening Meinesz

Fourth Evening Meeting, 19 December 1927. Colonel Sir Charles Close, President, in the Chair

Elections: Mrs. W. A. Benson; Elijah Wood Bowcock; Miss Irene Jenny Josephine Carlebach; Frederick Harry Eeles; John Harold Dickinson Fredericks; Capt. Jack Reginald Gray; L. Newton Hayes; Melville Maitland Heriot; Lt.-Col. Samuel Howard Hingley; The Rev. Vernon Yate

Johnson, M.A.; Major-General G. A. J. Leslie, C.B., C.M.G.; Malcolm Henry I. Letts; Edward Hillis Marshall, D.S.O., M.R.C.S., L.R.C.P.; Gilbert John Miles, M.A.; Ernest Frederick Pollock, J.P.; Miss Mollie Regan, L.L.A.; Capt. Stanley Alexander Renny; Victor Frederick Searson; The Rev. George Speedie; Arthur Fred Elliott Tearle; Henry George Watkins; Miss Vera L. Watson; Henry George Webster, B.SC.; John William West, B.A.; Mrs. Edward Woodhouse; Frank Yates.

Paper: Johore in 1926. By Capt. S. W. Kirby

Fifth Evening Meeting, 9 January 1928. Sir Charles Close, President, in the Chair

Elections: Major Arnold Morley Allen, M.C.; Mrs. G. B. Anderson; Camillo Marco Baroni; The Rev. Edward Barton; Capt. Charles Walter Dann, M.C., R.A.R.O.; William Henry Denson; C. Daryll Forde, B.A.; Albert L. Gilmore; John Hall; Miss Suzette Hawkins; Capt. Victor Christian Holland, R.C.S.; Wilfred Edgar Howarth, F.G.S.; Major C. O. Ibbetson; Ian Lawson-Johnston; William Herbert Pearce-Batten; George Shirley Rawlings; James Sing; Ishaq Yakub Suleman, B.A., B.T.; William Tytler.

Paper: The Nanda Devi Problem. By Dr. T. G. Longstaff

Third Afternoon Meeting, 16 January 1928. Sir Charles Close, President, in the Chair

Paper: The Physical Geography of South-East Arabia. By Mr. G. M. Lees

Sixth Evening Meeting, 23 January 1928. Sir Charles Close, President, in the Chair

Elections: The Rev. A. W. Banfield; Reginald Ernest Bath; Prof. Kali Shankar Bhatnagar, M.A., LL.B.; Herman Frederick Brownbill; Herbert Browning Button; Arthur George Collins; David Charles Edwards, B.SC.; S. C. Ells, B.A., B.SC., F.G.S.; M. Follick, PH.D.; Gandasingh-Kewal; William Morrow Gilmore; Reginald Landry; Herbert Frank Wightman Mountain; Raymond Nichols, A.M.INST.T.; The Rev. Herbert Poole; George Palmer Putnam; Edward Clive Rouse; Anthony George Carl Somerhough, R.A.F.; Major Robert Ferguson Stirling, F.R.C.V.S., F.Z.S.; Maj.-Gen. Arthur Grenfell Wauchope, C.B., C.M.G., D.S.O.; Capt. Josiah Arthur Webbe; T. T. Williams; George H. Wynell-Sutherland.

Paper: Some Valleys and Glaciers of Hunza. By Capt. C. J. Morris, I.A.

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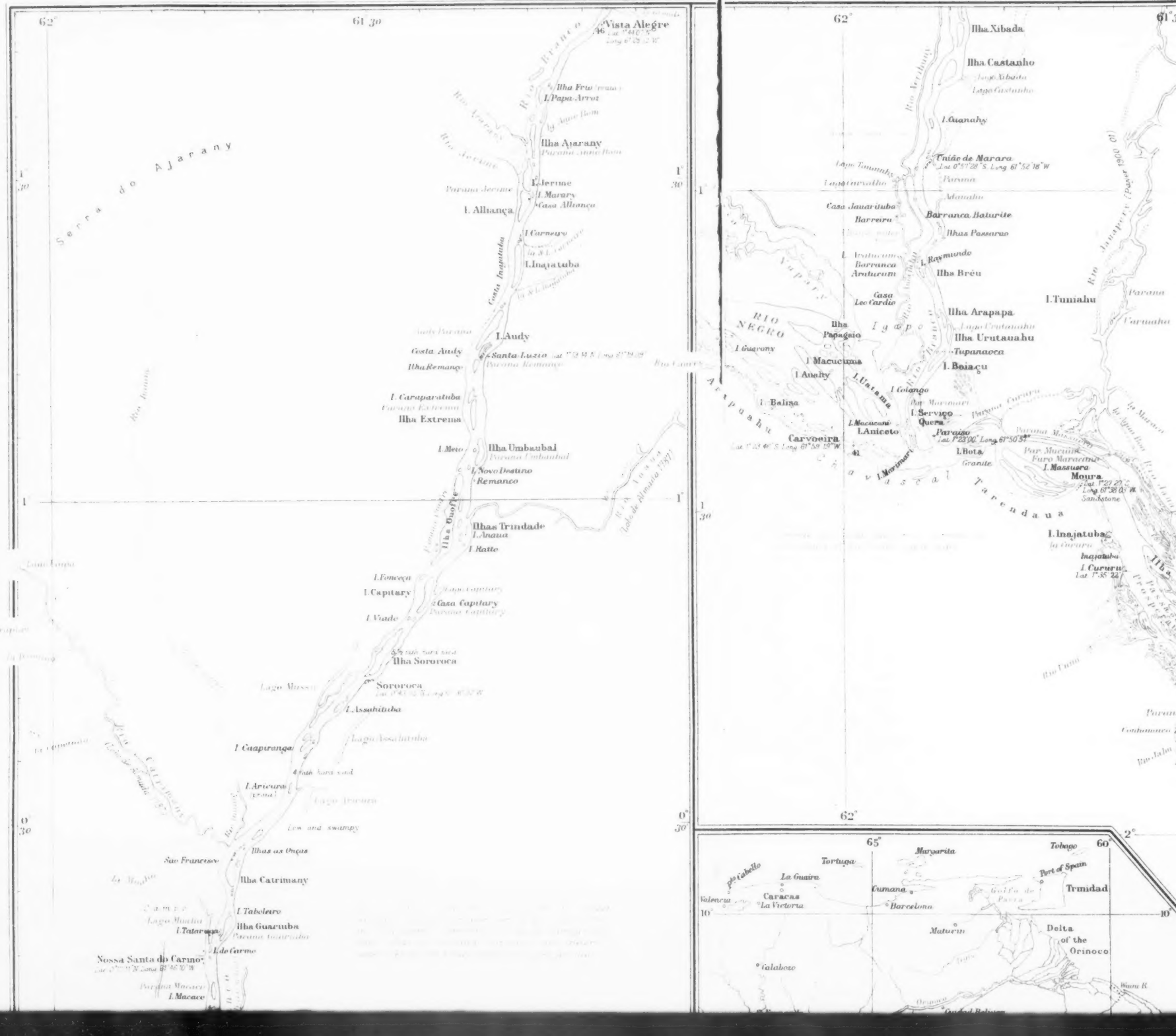
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Calaboco
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BRAZILIAN GUAYANA

Survey of the

LOWER RIO NEGRO AND THE RIO BRANCO

between Manáos and Vista Alegre

by the

Hamilton Rice Expedition 1924-25

Scale 1: 750 000

10 5 0 10 20 30 40

Statute Miles

10 5 0 10 20 30 40

Kilometres

This map has been made from boat compass traverses and sketches from hydroplane, supplemented by aerial photographs for the Rio Negro with distances by log and time, adjusted to astronomical positions from observations with six inch theodolites by Casella and Troughton & Simms fitted with Reeves' Prismatic Astrolabe Attachment: Dittisheim half chronometer and North & Sons stop watches: Time signals by wireless. Details are given in the paper which this map illustrates.

Reference

Barranca (Span.)	=	*High bank, earth cliff*
Barreira (Port.)	=	" " "
Boca	=	*Mouth*
Campo	=	*Treeless plain*
Casa	=	*House*
Chavascal	=	*Swampy bush*
Costa	=	*Mainland*
Igapo	=	*Land deeply flooded*
Igarape = Ig.	=	*Small tributary creek*
Ilha = I.	=	*Island*
Lago = L.	=	*Lake*
Malloca	=	*Indian house*
Parana = Par.	=	*Channel between islands, or islands and mainland*
Passagem	=	*Strait*
Praia	=	*Sandbank*
Tapera	=	*Abandoned house*
Terra firma	=	*Land above flood level*

\+ — *Points where observations were taken for latitude and longitude.*

* — *Observations for latitude only.*

Heights in feet thus 21

Parana Canumã

Parana Canumãzinho

Ilha Prosperança

Ilha das Onças

Rio Canumã

Rio Curuaha

Parana Curuaha

Ilha Jussara

I. Comarana

I. Curidiqui

Ayrão

I. Xipaca

I. Super.

I. Curiahu

São Francisco d'Assis

Ilha Jacare

Cachoeira

Rio Padauiry

Rio Mapuera

Rio Jatapu

Mirapeninna

I. Jauari

I. Gaviota

Parana Mapuera

Parana Jatapu

Rio Negro

Rio Branco

Parana Caracaraby

Parana Caracaraby Grande

Parana Caracaraby Pequeno

Parana Caracaraby Mirim

Parana Caracaraby Mirim Grande

Parana Caracaraby Mirim Pequeno

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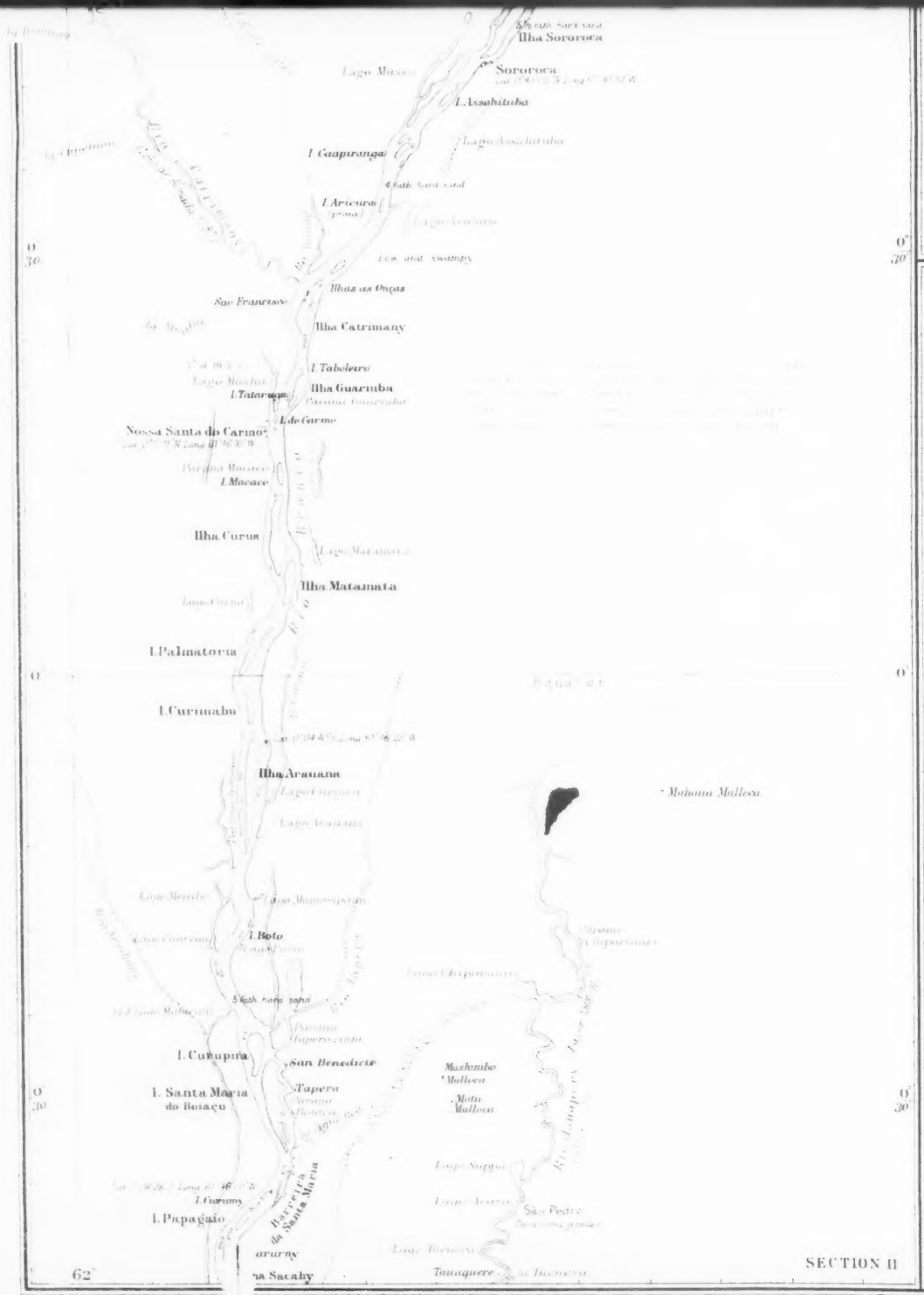

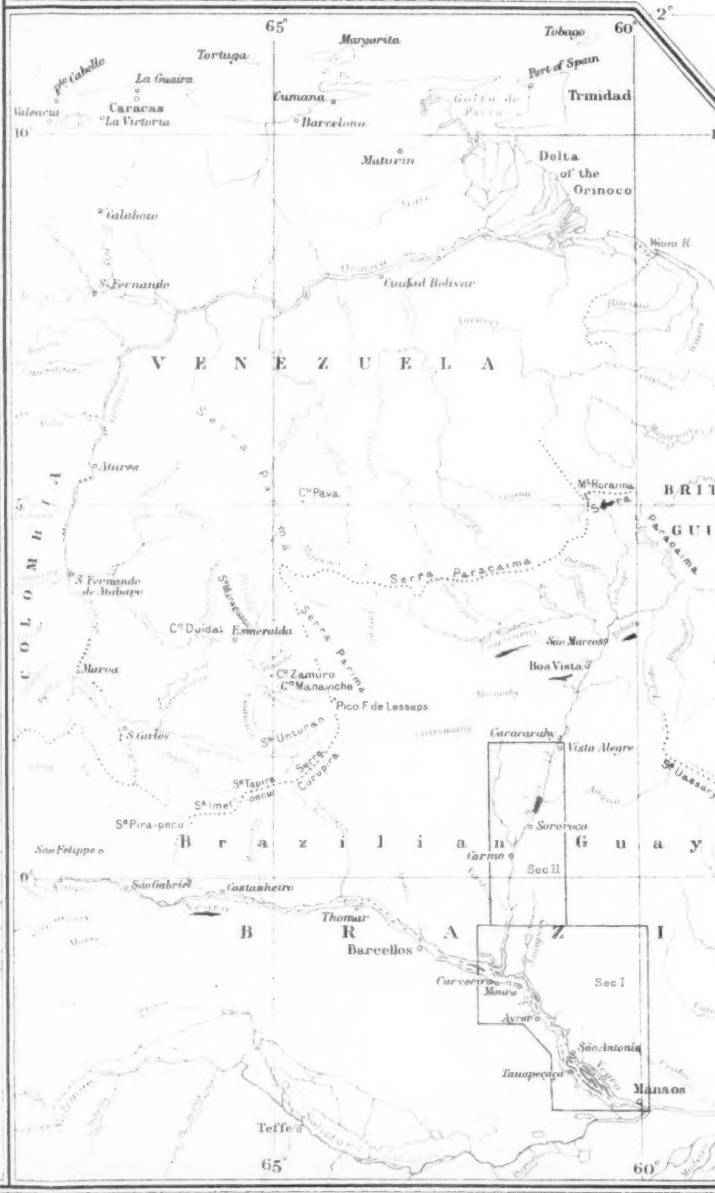

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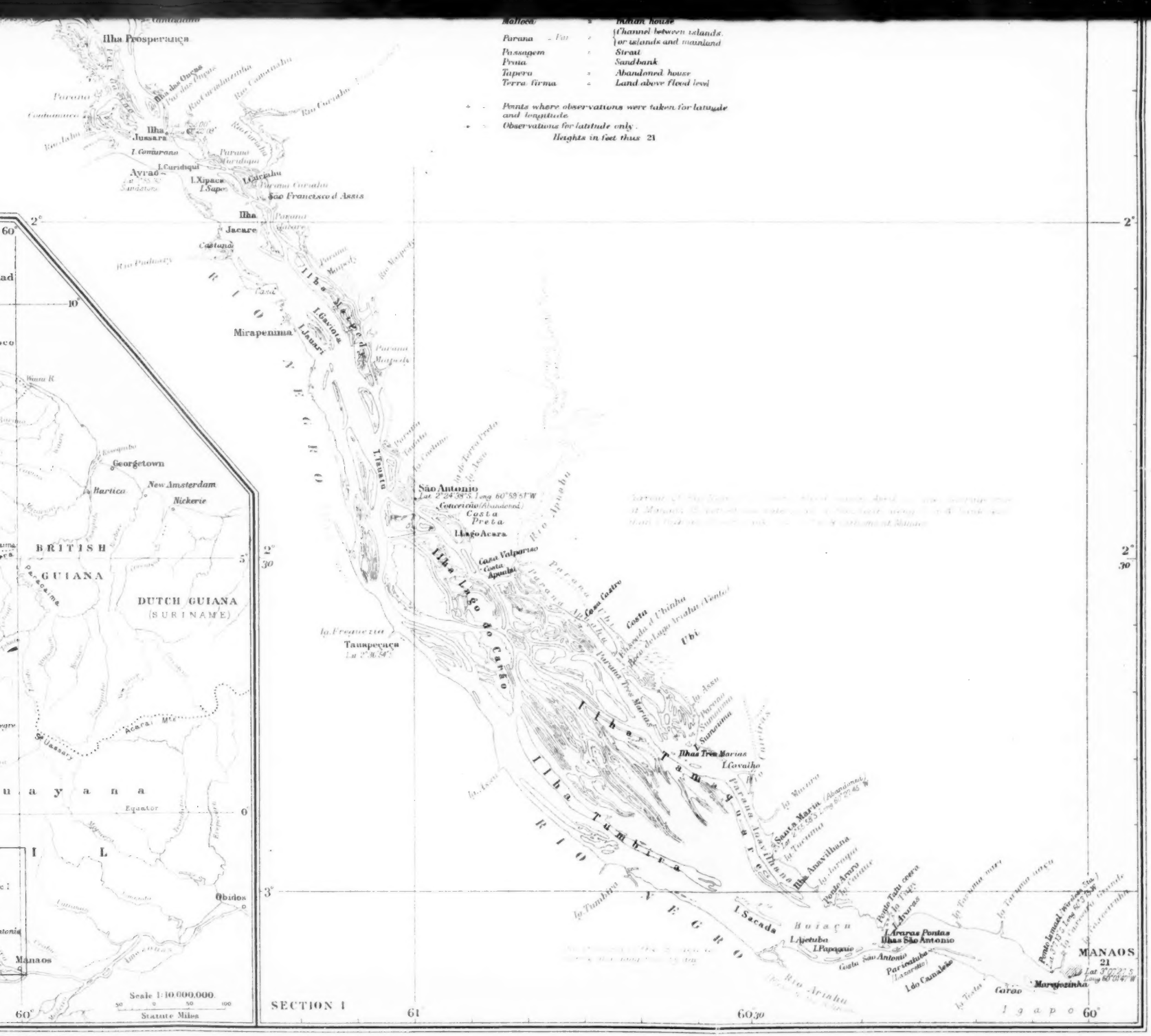

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